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ABSTRACT

The Marine Resources Panel addressed itself to three tasks: describing the current rate of exploration and exploitation of marine resources and the physical, economic, and legal conditions under which they are produced; identifying deterrents to development and efficient utilization of marine resources; and recommending programs that will remove the deterrents, thereby stimulating exploitation of marine resources. The topics assessed in this manner include fisheries, mineral resources, oil and gas, fresh water from marine resources, direct power from the sea, and recreation. The report of the International Panel concentrated upon those problems which were thought most important to the advancement of the objectives of the Marine Resources and Engineering Development Act of 1966. This report includes guides to U.S. policy, summary of principal recommendations and an international legal-political framework for exploring and exploiting the mineral resources underlying the high seas, exploiting the living resources of the high seas, conducting scientific inquiry in the oceans, and controlling the oceans. Alternative international legal-political frameworks are developed for exploring and exploiting the mineral resources of the deep seas and exploiting the living resources of the high seas. (BR)

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Marine Resources and Legal-Political Arrangements for Their Development

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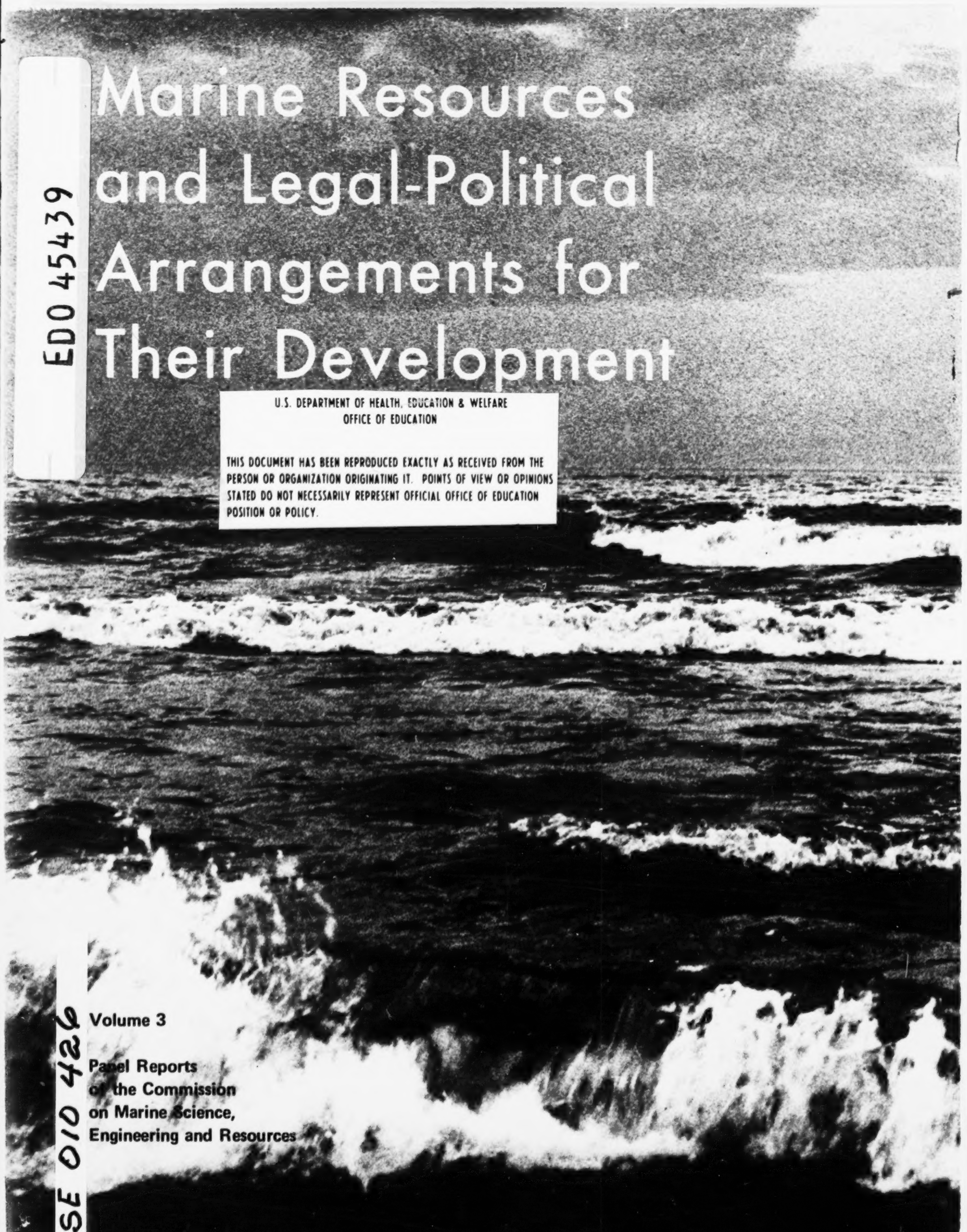

Volume 3

Panel Reports
of the Commission
on Marine Science,
Engineering and Resources

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Preface

The Marine Resources Panel of the Commission on Marine Science, Engineering and Resources has undertaken an assessment of the potential for marine resources in the context of anticipated demand and supply for the Nation and the world. The panel addressed itself to three essential tasks: describing the current rate of exploration and exploitation of marine resources and the physical, economic, and legal conditions under which they are produced; identifying deterrents to development and efficient utilization of marine resources; and recommending programs that will remove the deterrents, thereby stimulating exploitation of marine resources.

We have considered the term "marine resources" to include not only those organisms and substances that exist in the ocean water but also materials of potential value on and beneath the seabed. Approximately 20,000 species of fish–only a few of which are used by man, seaweeds, vast quantities of algae, and other simple organisms make up the living resources. Oil and natural gas; such dissolved chemicals as salt, magnesium, and bromine; sulphur; sand, gravel, and oyster shells; and tin are the major non-living resources already produced from the sea. Many more are potentially important. Fresh water may also be considered an important non-living resource.

Outdoor recreation, direct power, transportation, and underwater storage of materials are vital non-consumptive uses of the sea that can add wealth and enjoyment to our lives. Waste disposal is at present another major use of the sea. Recreation and power are discussed in this report; transportation, waste disposal, and storage are treated in other panel reports. Because of the diverse character of marine resources and their usage, the panel has treated each principal resource group separately.

The panel gathered information through consultants; correspondence with individuals from universities, industries, and Federal and State governments; previous studies of the problems; comments from technical reviewers; and direct interviews.

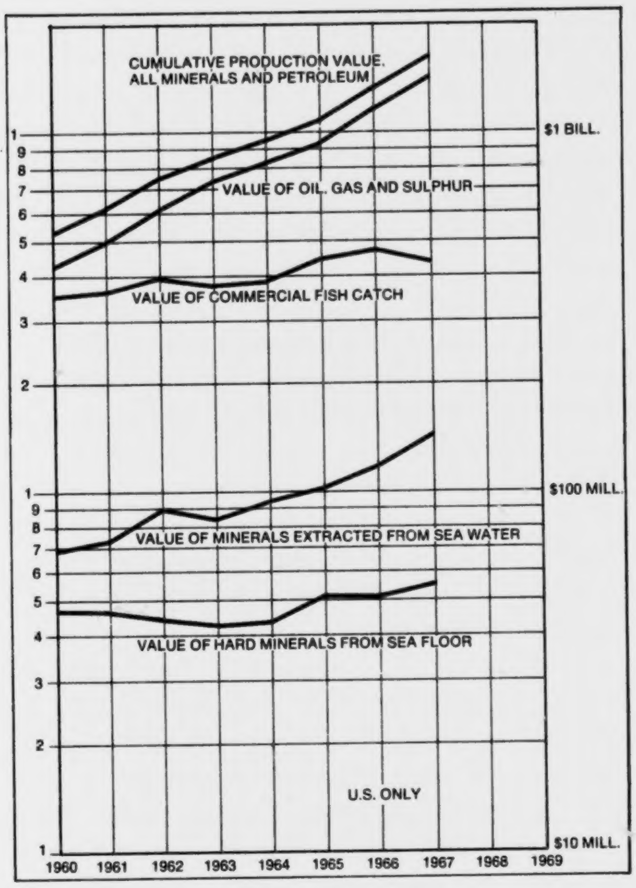
With respect to oil and hard minerals, industry and government are concentrated in relatively few institutions, and the panel consulted leaders in these areas. The fisheries, on the other hand, represent a mature and widely dispersed group of industries. To obtain the widest range of opinion, the panel sent letters inviting specific and general suggestions from every known organized group of fishermen's unions and cooperatives, processing and marketing firms, sport fishing groups, conservation organizations, and individuals concerned with the fisheries. Their responses aided in our preparations.

Our report was reviewed at several levels of development by members of government, industry, and the university community, and it benefited greatly from their wide diversity of experience. The report, however, is the sole responsibility of the panel.

We wish to thank all of the contributors to the report listed in Appendix A and to give special recognition to the assistance rendered by Creighton A. Burk, Mobil Oil Company; David B. Brooks, Bureau of Mines, Department of the Interior; D. L. Alverson, Bureau of Commercial Fisheries, Department of the Interior; and W. M. Chapman, Ralston Purina Company.

We especially wish to thank John P. Albers, Executive Secretary of the panel, whose dedicated assistance made this report possible. Upon Dr. Albers's departure, H. Crane Miller assisted in completing the report.

James A. Crutchfield, *Chairman*
David A. Adams



Value of resources extracted from the sea 1960-67.

I. FINDINGS AND RECOMMENDATIONS

World demand for protein food from the sea will continue to mount at a pace that necessitates adequate attention to efficient supply and development of new sources.

Recommendation:

The United States should assist developing nations through expansion of its own technical capability in marine fisheries and through vigorous support of multi-lateral fishery development programs such as those of the Food and Agriculture Organization of the United Nations, the United Nations Development Program, the World Bank, and other international agencies.

Despite wide variations in estimates of total food productivity from the sea, there is ample evidence that the supply of marketable food products (or of intermediate products that can be readily converted into food) can be expanded to four or five times present levels.

Recommendation:

Far better estimates of total food production, oceanwide and by specific regions and species, are needed. The United States should pursue its own research programs to improve these estimates, cooperate with international efforts along the same lines, and explore new techniques for rapid preliminary assessment of stock size and potential yield where new fishery developments are contemplated.

Present institutions for fishery regulation, where protection from overfishing is required, are grossly inadequate. Both internationally shared fisheries and inshore fisheries involve jurisdictional conflicts that have made effective management impossible from both the biological and the economic standpoints. In the absence of any control over entry, all mature fisheries are characterized by over-investment and economic waste.

Recommendation:

The United States must undertake a searching revision of its concepts of fishery management and regulation, with respect to both internationally shared and inshore fisheries. It should then put into practice new management methods to produce the largest net economic benefit, consistent with the biological capabilities of the exploited stocks and with equitable distribution of the proceeds and employment opportunities among participating fishermen. In the international field regulatory methods must be flexible enough to accommodate different National objectives and value systems.

Landings by the fishing fleet flying the U.S. flag have changed very little over the last 30 years, but there are wide differences in performance among various segments of the industry. Increased demand, arising from population growth and the expanded use of fish for animal feeding, has been met from imported sources, at an annual cost now about $735 million. There is no reason why marine products, any more than any other, must always be met from domestic production if cheaper sources can be found elsewhere. However, competition from imports has had serious effects on many U.S. fishing communities. Further, there is clear evidence that U.S. fisheries could contribute more substantially to satisfaction of domestic demands.

Recommendation:

Research, development, and management efforts of the U.S. Government should be directed toward improvement of the competitive position of U.S. fishermen, with particular emphasis on increasing production by U.S. flag vessels from latent resources adjacent to our own coasts.

The major barriers to improved efficiency and technological progressiveness in the U.S. flag fisheries are to be found in the welter of institutional impediments that have grown up over many years.

Restrictive legislation, reflecting gear conflicts among fishermen, disagreements over sport and commercial usage, and other local partisan interest, has grown to massive proportions. The term "conservation" has been used to justify a great many restrictive actions that serve no useful purpose in resource management but inhibit severely the development of efficient fishing methods and equipment.

Recommendation:

A series of searching studies should be initiated to define the effects of these institutional impediments, area by area and fishery by fishery. To the extent that these restrictive measures involve management programs, they must be corrected by action of the individual States or by groups of States sharing common fisheries.

Several possible organizational arrangements for U.S. commercial fisheries have been reviewed; the panel has concluded that the role of the Federal Government should be reoriented toward resource development and the concentration of manpower and financial resources on National fisheries missions. Studies of fishing management and regulatory concepts should be undertaken and new management techniques instituted calling for increased coordination among the States and a greater Federal role in determining National fisheries policies and priorities.

Recommendation:

Federal authority over U.S. marine and anadromous fishery activities should be combined in a single bureau of one agency. The agency should be authorized to establish National priorities and fishery policies for migratory marine species for commercial and recreational purposes. It should encourage cooperative activities by States for regulation and conservation of such species, sponsor research on the impact of institutional barriers inhibiting efficient development of our fisheries, and encourage enactment of improved State and Federal laws relating to regulation and conservation of such fisheries.

Under certain circumstances the measures proposed above may be inadequate to meet the development and management needs of certain fisheries. Under conditions stated below, Federal regulatory jurisdiction of endangered fisheries should be asserted.

Recommendation:

The Federal Government should be given authority by the Congress to assume regulatory jurisdiction of endangered fisheries when:

–It can be demonstrated that a particular stock of marine or anadromous fish migrates between the waters of one State and those of another or between territorial waters and the contiguous zone or high seas;

–The stock enters into interstate or international commerce;

–Sound biological evidence demonstrates that the stock has been significantly reduced or endangered by acts of man;

–The State or States within whose waters these conditions exist have not taken effective remedial action.

There is urgent need for defining a limited number of specific missions designed to expand the income and employment generating capacity of the American fishing industry on a commercially viable basis. Rather than talking in general terms about rehabilitation, the Bureau of Commercial Fisheries should identify specific geographic areas and fish stocks where expansion is economically justifiable and biologically feasible.

Recommendation:

The Bureau of Commercial Fisheries should analyze each major fishery and develop integrated programs designed to exploit those fisheries where opportunities for expansion exist.

There are serious deficiencies in the overall organizational structure and budget of the Bureau of Commercial Fisheries that reflect a combination of constraints, some of which are attributable to BCF and some to the pressures to which it is subjected.

Recommendation:

The Bureau of Commercial Fisheries should be reorganized to achieve: program rather than project orientation, National rather than regional determination of programs priorities, and greater flexibility in its use of funds and manpower. BCF's budget should be expanded moderately.

Production of many important species of fish and shellfish depends on the preservation of adequate environmental quality in estuarine and shoreline areas. The present division of authority and inadequate scientific basis for management of our estuarine areas have opened the door to activities that inflict heavy damage on fisheries as well as on other potential beneficial users of these waters.

Recommendation:

Fishery scientists and management personnel must participate with other relevant disciplines in a fully integrated, large scale attack on the problems of the estuaries and inshore areas. The panel endorses the programs recommended in the Report of Panel on Management and Development of the Coastal Zone.

Much of the panel work of the Commission has focused on gaps in U.S. ocean engineering capability. This has its counterpart in the fisheries.

Recommendation:

A much larger and more imaginative effort by the Bureau of Commercial Fisheries and State agencies should be undertaken to: (1) evaluate current procedures for providing current information needed to deploy fishing fleets properly, (2) push development of technological innovations through to the practical application stage, and (3) apply new materials and methods to the two essential operations of high seas fisheries, search (detection) and capture. A major increase is required in the amounts budgeted for applied research in fishing gear, techniques, and materials.

Fish protein concentrate offers possibilities for extended use of otherwise unmarketable products from the sea and possesses physical characteristics that make it highly useful in supplementing protein deficiencies in some critical areas of the world.

Recommendation:

The present marginal financing of the food protein concentrate program in the Bureau of Commercial Fisheries should be expanded and firmed up. In addition, BCF must establish better relations with firms in the private sector that must ultimately carry the burden of production, distribution, and sale of end products.

The fruits of expanded Government programs to improve U.S. fishing technology and resource assessment will not be realized until translated into action by the industry. The decentralized, small-scale character of the U.S. fish harvesting industry and the wide diversity of regional fisheries make it very difficult to make such information available to fishermen in a manner that permits them to use it.

Recommendation:

The Bureau of Commercial Fisheries should be authorized to develop an extension service, possibly in cooperation with Sea Grant institutions, to bring technical developments into practical application.

The present Federal program for modernization and rehabilitation of the U.S. fishing fleets through subsidization of new construction is deficient in concept and will not achieve the desired objective. In addition, the program as presently formulated is adding to fishing capacity in fisheries already subject to such intensive effort that conservation measures are required. The result is to foster inefficiency for the industry as a whole despite the introduction of new and relatively efficient individual units.

Recommendation:

The most logical solution to the problem of the subsidy program is to permit U.S. fishermen to buy vessels and equipment anywhere in the world where they can find the best combination of price and performance. If a subsidy program is to be carried on, it should be accompanied by a retirement program under which new and efficient

capacity is matched by retirement of older vessels in order to prevent excessive expansion of total fishing effort and should be restricted to fisheries in real need. It would also be more accurate and effective to regard the program as a subsidy to the U.S. shipbuilding industry and move it outside the budget of the Bureau of Commercial Fisheries.

Several incidents of food poisoning in recent years have drawn public attention to inadequate sanitary conditions in many processing and marketing establishments throughout the country. It is estimated that less than one-third of the 4,200 fish processing plants in the United States could meet standards equivalent to those required of meat and poultry packers. In addition, industry representatives at a recent fishery conference cited improved quality control as the most important requirement in building stronger U.S. markets for seafood.

Recommendation:

The panel endorses the President's request for legislation requiring mandatory inspection of fish, fishery products, fish processing plants, and fishing vessels. It recognizes, however, the need for interim financial and technical assistance to assist firms in upgrading facilities and recommends that the Bureau of Commercial Fisheries undertake such assistance.

There are good opportunities for expansion of the presently limited culture of shellfish and a few high-value fin fish to other species and new areas. The long run potential for major increases remains essentially unknown, but it could be significant.

Recommendation:

A carefully planned, long range program of biological research and development of technical requirements should be initiated at this time for expansion of aquaculture in the estuarine and marine environment.

Present statistical data on U.S. commercial fisheries are inadequate for biological, technological, and economic research needs and for resource management. Sport fishing statistics are even less complete and reliable.

Recommendation:

Programs must be developed to fill more adequately the gaps in present State data collection programs, either by financial assistance to the States or by direct participation of Bureau of Commercial Fisheries personnel. In addition, there is urgent need for standardization of statistical materials and compilations. An even larger effort is required and should be undertaken to develop an adequate statistical program for sport fisheries.

Some conflict between commercial and recreational utilization of marine fish stocks is inevitable. The two groups of users may exploit the same species; they may use gear that is mutually incompatible in the same area; they may interact through common forage species; and each may inflict restrictions on the other through biased legislation and regulation. Though the extent of the competition is frequently overstated, failure to recognize and resolve it properly has resulted in serious losses to both sport fishermen and commercial users. To a very large extent, resolutions of these conflicts in orderly fashion is a responsibility of the States. Nevertheless, the Bureau of Commercial Fisheries and the Bureau of Sport Fisheries and Wildlife can do much to minimize unnecessary conflicts.

Recommendation:

The Fish and Wildlife Service can and should take the lead in devising sensible criteria for allocating fish among competing uses and encouraging uniformity in their application by the various States. Specifically, it can assist through: (1) provision of better statistical data; (2) expanded working relations with State, interstate, and international government bodies on the one hand, and with commercial and sport fishermen groups on the other; and (3) by active promotion of greater uniformity in State legislation affecting both commercial and sport fishing.

The scattering of ocean science, technology, and resource activities among Federal agencies has made it difficult to develop or implement National policies for fisheries management and development.

Recommendation:

A single agency of Government, with broad responsibility for ocean science, technology, and use, should be created. A strengthened National fishery agency, encompassing both sport and commercial fisheries and empowered to implement National objectives for development and management of U.S. fisheries throughout the world, should be an integral part of that agency.

II. INTRODUCTION

Although the spectacular growth of offshore oil production and the prospect of moving to the sea and the sea bottom to meet the insatiable demands for mineral resources have captured the public imagination, living resources of the sea still provide the most important contribution to man's well-being from the marine environment. Unlike many other aspects of the activities with which the Commission is concerned, the industries exploiting the sea fisheries are as old as recorded history; they are shared by every coastal nation in the world and by some that do not border on salt water. To the richer nations, the sea offers diversity in the diet and a healthful, easily digested form of animal protein that can now be made available at all seasons of the year. To the less fortunate nations, the oceans provide one of the more accessible and expansible sources of desperately needed protein foods; here success in developing marine fisheries is literally measured in lives.

The panel has taken as its frame of reference world supplies and demands for living resources from the sea, rather than confining its attention exclusively to the United States, for two reasons. First, the national commitment to the war on hunger, as one aspect of the international effort to close the growing gap between have and have-not nations, lends a special significance to exploratory and developmental programs aimed at creating or expanding local fisheries in underdeveloped areas. The export of American technology, managerial skills, and research results is, in many cases, the most efficient way of contributing to world use of the sea to speed development in the emerging economies. Second, the distinction between national and international fishing operations is becoming less meaningful each day. From the demand side, modern processing technology has made seafoods an increasingly important item in international commerce, linking all the major producing nations and consuming centers. From a production standpoint, revolutionary changes in the range, efficiency, and diversity of modern high seas fishing vessels have made it possible for large modern fleets to fish anywhere in the world ocean. Though the deteriorating position of the American fishing fleet is a matter of deep concern to the Commission, its rehabilitation must be viewed within the broader framework of the U.S. contribution to both national and international usage of the living resources of the sea. By the same token, efforts to expand the contribution of American flag vessels must be undertaken in full recognition of the international competitive situation: economic, technological, and legal.

To simplify the following discussion, the term "fishery" is used in a general sense to include harvesting of all living resources of the sea, including fin fish, mollusks, crustaceans and edible sea-weeds. Brief reference is made to the use of marine plants for non-food purposes and to the possibility of producing pharmaceuticals from the sea.

III. THE WORLD FISHERIES

A. The Importance of Marine Fisheries

Present world production of fish and shellfish, according to the Food and Agriculture Organization of the United Nations, is in the neighborhood of 57 million metric tons. This represents about 10 per cent of total animal protein production. These gross figures conceal, however, the very real economic and social significance of marine fishery products, regionally and nationally. For some nations, food from the sea represents an indispensable source of animal protein, without which presently deficient diets would become disastrously inadequate. Virtually all of Asia and Africa fall in this category. For others, high per capita consumption is not a matter of life, death, or even health, but rather a matter of strong preferences; the Scandinavian countries might be cited as an example. In still other nations food from the sea represents an important source not only of domestic protein but of foreign exchange as well. Both fish and fish meal are significant items of international commerce, and nations such as Iceland, Peru, Japan, and Norway are heavily dependent on exports of processed fish products for stability in their balance of payments. For obvious reasons, fishing activities and the related processing and waterfront activities tend to be centered geographically in areas frequently deficient in other employment and investment opportunities.

In brief, the relatively small numbers associated with the world's marine fisheries, in comparison with other sources of food, should not conceal the fact that they are of very real economic importance, and efforts to improve the performance of these industries, whether by increasing output, reducing costs, or both, should be pursued vigorously.

B. Demand

The primary determinants of the demand for fish and shellfish are: (1) the level of personal income per capita; (2) aggregate size and rate of growth of the population; (3) tastes and preferences, including the influence of customs reflecting religious practices and national origin; (4) price and availability of closely substitutable products, of which meat and polutry are the most important.

The strength of world demand for protein food is evident in the rapid growth in production of marine seafoods during the past three decades. Landings of fish and shellfish have been growing at a rate of more than six per cent a year since the end of World War II. As indicated in Figure 1, total landings have jumped from about 20 million metric tons in 1950 to about 57 million tons in 1966, of which at least 50 million tons came from marine sources. The areas of strongest demand spread across the entire spectrum of marine seafoods. Specialty processed fish and the more exotic forms of fish and shellfish are among the highest priced foods in the markets of the developed countries, and demand for them continues to grow rapidly. At the other end of the spectrum, demand for low priced fish, though changing with respect to preferred forms of preparation, continues to expand equally rapidly in many of the less developed nations. A forecast of world population growth would, accordingly, provide a good indication of the minimum rate of growth expected in demand for marine food products.

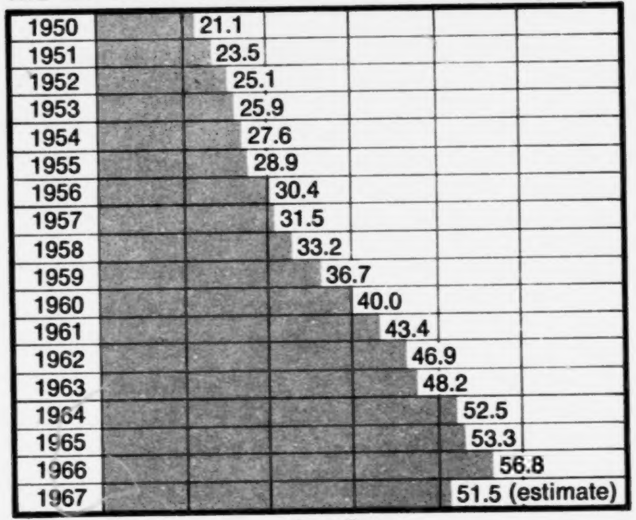


Figure 1. *Total world catch, 1950-67 (millions of metric tons). Source: Data from Food and Agriculture Organization of the United Nations, Yearbook of Fishery Statistics, 1966 (1968).*

The internal structure of this growing demand is of great interest in analyzing the nature of the markets that are emerging for living products of the sea. In the more highly developed nations, there is a marked tendency for per capita direct consumption of seafoods to level off. This is, in general, an extension of the simple physical fact that the total food consumed by man is largely a function of the size of his body; as incomes increase beyond the level at which adequate caloric and nutritional need is assured, consumer demand reflects more and more heavily the desire for diversification and for processing and marketing sources that make food products more convenient to handle and prepare.

The relative stability in per capita demand for fish and shellfish for direct consumption in the United States conceals wide variations among species. In general, demand for products of unusually good flavor and texture, such as fresh and frozen salmon, shellfish, lake trout, and red snapper is sensitive to rising real incomes and has been very strong throughout the postwar period. Similarly, demand for species used to produce frozen sticks and portions and canned tuna, where a high degree of consumer convenience has been linked to effective merchandising programs, has been good throughout the period. On the other hand, there is a marked tendency for lower income groups to shift away from cheaper fish, particularly in the South and in coastal areas, toward meat, poultry, and other preferred protein foods as their economic lot improves.

Of greater long run significance is the rapid growth in the demand for fish as an intermediate product. The per capita demand for fish in the developed countries must be revised to include the huge and continuing increase in consumption of marine fish products in the form of fish meal. High quality protein meals have now become a standard element in feeding programs for poultry and meat producers, and though they are sharply competitive in these uses with other sources of protein, such as soya bean meal, they are continuing to expand their market position and will do so as long as the relative prices of fishmeal remain favorable. Though fish meal is produced from smaller fish, generally commanding much lower prices than those consumed directly by human beings, its contribution to a varied and high quality protein diet is no less real. There is no reason why the food industry should not use land animals as converters of forage fish rather than tuna or other predators in the sea.

While it is difficult to generalize about all underdeveloped areas, there are certain common characteristics of the demand for marine seafoods in these countries. The most striking is the strength of the demand for fish, not only for its important nutritional characteristics in areas subject to chronic protein and caloric deficiencies, but on grounds of tastes and preferences. Though much has been made of the isolated cases in which protein deficiency exists side by side with abundant fish supplies because of religious or other taboos, these are rare exceptions indeed. In most of the emerging economies with access to the sea, fish have always provided an important source of food, and rising incomes, particularly in the rapidly growing urban areas oriented to international trade, have typically produced a striking increase in the demand for fish. Similarly, wherever technological developments have expanded sharply the capacity of indigenous fisheries (or created new ones), the task of creating the necessary processing and marketing apparatus to distribute the increased landings has been, on the whole, much easier than expected because of the strength of demand for the products.

The demand for fish has also responded positively, and will continue to do so, to improvements in nutritional knowledge and in the quality and diversity of fish products. Even in areas where taboos against consumption of fish have been relatively strong, the use of fish as food in schools, hospitals, and other institutions, coupled with a rising literacy rate, has tended to break down the resistance to using marine resources. Finally, these are the areas of the world in which population is increasing most rapidly. (Christy-Scott, 1965)

These, then, are the forces behind the rapid post-World War II increase in demand for fish products. Nothing in the current or prospective market situation would indicate any decline in the rate of increase in demand for fish products in the near future, and only revolutionary changes in social attitudes toward population control would produce any perceptible slowing down in that growth over longer periods. Clearly, the market is there; the physical need is there; the task is to appraise accurately man's ability to meet those needs and to do it as efficiently and expeditiously as possible. There does not seem to be any major reason to regard demand as a serious constraint on the ability to expand world fishing operations on a profitable basis.

C. Production Possibilities from the Sea

Interest in the ocean's living resources is not new, and literature dealing with conservation and ocean resources dates well back into English history. In the early part of the 13th century conservationists were pleading for restrictions on man's fishing techniques lest he destroy the coastal resources. In more recent times it would appear that Thompson (1951), at a United Nations-sponsored conference on the conservation and utilization of resources, was one of the first to estimate production capability of the oceans, and to demonstrate the pitfalls involved. From a known production (18 million tons) he estimated that a 20 per cent increase over prewar catches was possible; that is, about 21.6 million metric tons per year. This estimate excluded the catch taken by the U.S.S.R. and the yield from fresh and brackish waters. Of course, this estimated potential was exceeded by the middle of the past decade.

In recent years a number of fishery scientists and oceanographers have become seriously concerned to provide a more systematic appraisal of the ocean's fish potential. Despite their efforts, however, current estimates range from approximately 55 to 2,000 million metric tons annually, a range much too great for comfort in view of the pressing need for protein foods and the urgency of fishery management and development problems. If, however, these yield forecasts are examined in light of the methods and assumptions which various authors have employed, the range (55 to 2,000 million metric tons) is understandable and, to a degree, reconcilable. It is necessary, first, to distinguish between production and yield. Production is the total product of the biological activity including some that is taken by non-human predators. In no case is primary production fully harvestable. Table 1 provides specific estimates of world marine fish and shellfish potential by various authors, the year the forecast was made, and the technique employed in making the estimate. Several estimates are given for some authors who employed several techniques and various assumptions in their forecasts. Where multiple values are given the underlined figure is the one commonly attributed to the author.

Examination of Table 1 brings out certain relationships among these estimates. Those based on extrapolation from existing catch or fishing patterns give values at the low end, ranging from 50 to 160 million metric tons (Finn 1960, Graham and Edwards 1962, Meseck 1962, Schaefer 1965, Alverson 1965). As the Graham and Edwards estimate involves only bony fishes, a comparable figure based on their techniques would be somewhat higher. A mean value for these estimates would be about 85 million metric tons.

Those scientists who have based their analyses on theoretical energy flow through the food chain show estimates on the high side of the projected total yield. There are some obvious reasons why these projections or estimates would be higher than those based on past catch patterns. Several of the authors have, in fact, estimated the *biological potentialities* of the system; they estimate total gross production at some stated trophic level independent of physical and/or economic capability by man to intervene. Thus, Chapman's 2,000 million metric tons represents theoretical total available biological production, as does Pike and Spilhaus's 180 to 1,400 million metric tons. When realistic limitations based on technological capabilities and human tastes and preferences are imposed, the figures are much lower (e.g., Schaefer 200, Pike and Spilhaus 200, Bogdanov 80 and Graham and Edwards 60 million metric tons). If one adds to Graham and Edwards' figure other

Table 1

ESTIMATES OF TOTAL OCEAN YIELDS OF AQUATIC ANIMALS

Forecast (million metric tons)	Year	Method	Author
21.6	1949	ext.[1]	Thompson
55.4	1955	ext.	FAO
50 to 60	1960	ext.	Finn
55 (bony fishes)	1962	ext.	Graham & Edwards
55 (by 1970)	1962	ext.	Meseck
60 (bony fishes)	1962	ext. mf.[2]	Graham & Edwards
66 (by 1970)	1965	ext.	Schaefer
70 (by 1980)	1962	ext.	Meseck
60 to 80	1965	ext.	Alverson
70 to 80	1965	ext. ef.	Bogdanov
115 (bony fishes)	1962	mf.	Graham & Edwards
160	1965	ext.	Schaefer
200	1965	mf.	Schaefer
200	1965	mf.	Pike & Spilhaus
1,000	1966	mf.	Chapman
180 to 1,400	1962	mf.	Pike & Spilhaus
2,000	1965	mf.	Chapman

Source: Schaefer and Alverson (1968).

[1] ext. = Extrapolated from catch trends or existing knowledge of world fish resources.

[2] mf. = Energy flow through food chain.

marine animals discarded in their estimate, the corresponding value is 171 x 10^6 (Schaefer 1965). The range of estimates from this group—80 to 200 million metric tons—is understandable, in view of limitations on basic scientific information now available. Only Chapman's figure of 1,000 million metric tons for existing technology appears out of line in terms of the other estimates.

If we consider together estimates based on catch trends or present fishing patterns with those which follow material through the food chain, it is necessary also to consider man's technological and economic limitations; the range then runs from 55 to 200 million metric tons (excluding Chapman), with the majority less than 100 million metric tons.

Those estimates that are based on total primary production differ in assumed amounts of carbon fixed annually, in the ecological efficiency factor employed, and the level of harvest. Much of this is still controversial and our knowledge is simply insufficient to make an intelligent choice among differing views. Some of the confusion has resulted from authors jumping back and forth between wet weight, dry weight, fixed carbon, and total weight; and it should be remembered that the amount of organic matter produced annually by photosynthesis is still subject to much uncertainty. A comparison of some of the estimates dealing with this subject is given in Table 2.

Selecting any author's starting value, it is possible to develop a theoretical yield by trophic levels for various ecological efficiency transfer rates as indicated in Table 3.

Table 2
AVERAGE ANNUAL PRIMARY PRODUCTION OF ORGANIC MATTER
(in dry weight)

Steeman Nielsen	30 x 10^9 tons
Riley	260 x 10^9 tons
Zernov	120 x 10^9 tons
Skopintsev	90 x 10^9 tons
Wiborg	(70 to 140) x 10^9 tons
Sverdrup and Fleming	(100 to 200) x 10^9 tons

Source: Bogdanov (1966).

A more meaningful way of expressing the problem would be in terms of the supply function concept common to economic and business ana-

Table 3
POTENTIAL HARVEST OF THE SEA
ESTIMATES OF POTENTIAL YIELDS[1] (PER YEAR) AT VARIOUS TROPHIC LEVELS, IN METRIC TONS

	Ecological Efficiency Factor					
	10 per cent		15 per cent		20 per cent	
	Carbon	Total Weight	Carbon	Total Weight	Carbon	Total Weight
Phytoplankton (net particulate production)	1.9×10^{10}		1.9×10^{10}		1.9×10^{10}	
Herbivores	1.9×10^{9}	1.9×10^{10}	2.8×10^{9}	2.8×10^{10}	3.8×10^{9}	3.8×10^{10}
First stage carnivores	1.9×10^{8}	1.9×10^{9}	4.2×10^{8}	4.2×10^{9}	7.6×10^{8}	7.6×10^{9}
Second stage carnivores	1.9×10^{7}	1.9×10^{8}[2]	6.4×10^{7}	6.4×10^{8}	15.2×10^{7}	15.2×10^{8}[2]
Third stage carnivores	1.9×10^{6}	1.9×10^{7}	9.6×10^{6}	9.6×10^{6}	30.4×10^{6}	30.4×10^{7}

Source: Schaefer (1965).

[1] Output to predation at each trophic level.

[2] NAS Committee estimates (approximately).

lysis. If one were to plot the quantity of fish and shellfish that would be forthcoming at successively higher relative prices–i.e., supply response to secular growth in demand with its accompanying growth in prices–one would obtain an estimate of production from the sea that will yield an economic return equal to or greater than that from other goods or services produced with the same capital and labor inputs.

It must be stressed, however, that a supply function of this type is strictly static in nature. Over time, increased rates of use of existing fishery resources generate pressure on costs but also generate incentives to relieve the pressure in a variety of ways. There is a strong business incentive to find ways to exploit presently underutilized or unutilized species; to reduce fishing costs and thus to extend the geographic coverage of the industry; and to devise new processing and marketing methods that will increase consumer acceptance.

A supply function geared entirely to present fishing technology, present fishing locations, and present patterns of demand would probably show rapidly increasing costs at an output of perhaps 75 to 85 million metric tons. However, if account is taken of recent improvements in vessel and gear technology, in our ability to preserve the quality of sea foods during storage and transportation, and in our capacity to alter the physical composition of marine products in order to improve their marketability–all products of research, development, and simple business ingenuity–it is clear that the aggregate potential from the sea is much greater than such a static analysis would suggest. And this means greater yield in the economic sense: that is, output that can be sold profitably at market-determined prices.

Two current examples might be cited. The development of new fishing methods tailored to a specific set of fish characteristics has opened the way for a new industry on the Pacific coast on reduction of previously unused hake stocks. The development of economically feasible fish protein concentrates promises even greater opportunities to turn fish previously regarded as scrap into profitable products.

The nature of the long run supply function and its dynamic movements over time cannot be determined from a simple extrapolation of historical data. In broad terms, the first decade after World War II was marked by a significant expansion of fish landings, largely from areas previously fished and from species known to exist in marketable quantities. The increase came in part from the accumulation of stocks on areas fished more lightly during World War II and in part from improvements in gear and vessels. In a second phase of expansion, now tapering off, the increase was carried forward by geographic expansion of world fishing in general and by further improvements in gear and fishing techniques. Several new fisheries were brought into production, of which the most spectacular was the growth of the anchovetta fishery in Peru. The coasts of West Africa and South America came into much greater prominence with rapid increases in landings of both demersal and pelagic species. Expansion of market interest in and production of tuna and tuna-like fishes and billfish in tropical waters extending westward and eastward from each of the major continents has continued. Expansion of shrimp production has gone forward steadily; more than 50 nations are now engaged in the operation.

Again, however, this type of expansion is bound to be self-limiting, since it involves exploitation of Continental Shelf fish and shellfish (and the relatively high-priced pelagics) that can be taken with known fishing techniques. This suggests that further expansion will come from a wide variety of innovations to permit harvesting species that cannot be utilized economically with present methods and conversion of previously unmarketable fish to products that are profitable. There are very large populations of edible pelagic fish (or of fish capable of being converted into fish meal or edible fish protein concentrate) that are lightly fished or completely unused, but problems in locating, concentrating, harvesting, and processing remain to be solved before these stocks can become economically significant resources. Utilization of some species is also held back by inadequate knowledge of yield potentials and uncertainty about parameters determining availability. It may well be, then, that we will see a new surge of activity, but only after a time lag determined largely by the vigor with which national and international oceanography effort is pressed.

The vigor with which truly international fishery operations are being developed is indicated by the fact that 20 nations are now fishing off the southwest coast of Africa with modern long range vessels. These include, among others, South Korea, Nationalist China, Israel, Bulgaria, Rumania, Egypt, and Greece. The rapidly developing fisheries on the Continental Shelf of South America, south of the Rio de la Plata, are shared not only by South American nations but by Cubans, Spanish, Russians, Japanese, and others. There is already serious concern about declines in productivity on the major trawling grounds off the coast of Mauritania and Senegal, where more than 200 large, modern, oceangoing trawlers are now operating on a year-round basis. Rumanian vessels are active off the coast of New Zealand, and the Kuwaiti are involved in development of the shrimp fisheries off North Borneo. The pace of this development is such that unless some effective means of developing the necessary scientific knowledge on yield potentials (and an adequate control mechanism to prevent exceeding these limits) is forthcoming, the economic effect of any improvement in technology or markets is likely to be vitiated by over-exploitation of existing stocks, unless the technical breakthroughs that will move us into a new era of wider ocean fishing and further diversification in exploiting shelf species are achieved.

D. Potential and Present Degree of Utilization by Area

Few efforts have been made to break down total potential yields by geographic areas, although many have discussed the subject in terms of likely areas for growth potential. Meseck (1962) presented what was then the best and most complete treatment of total yield estimates by geographic areas. On the basis of admittedly insufficient knowledge he suggests potential area yields shown in Table 4. Present production (1965) is shown in the last column. Current developments have already made it clear that these estimates are inadequate, however, and more defensible figures are now in preparation in FAO as a part of the Indicative World Plan.

Table 4
PROJECTED YIELDS BY 1980 AND PRESENT PRODUCTION
(million metric tons)

Continent	Forecasted Production	1965 Production
Africa	8	3.0
North America .	9	4.4
South America .	10	9.0
Asia (except USSR).	22	20.0
Europe (except USSR).	10	10.8
Oceania	3	.2
USSR	5	5.0
Total . . .	70	52.14

Source: Forecasted production, Meseck (1962); 1965 production, FAO Yearbook, 1966.

Those who have dealt with food chain relationships as a means of estimating fish potentials have not partitioned them by geographic areas. As they are devised either from average ocean productivity or from integrated values based on varying productivity rates, one might arbitrarily allocate such estimates according to ocean surface areas, as follows: Pacific, 53 per cent; Atlantic, 25 per cent; Indian, 22 per cent.

The relative degree of utilization of the ocean's fishes in an aggregate sense might be approximated by the ratio of present production to total potential yields estimated by various authors. For those estimates based on catch trends and fishing patterns and limited by present technology, the ratios, as of 1964, would run from approximately 25 to 92 per cent utilization. In terms of biological potential, however, the ratio of harvest to total yield potentials ranges from about 3 to 25 per cent.

It is possible to make some useful general statements about the relative utilization of major groups of marine animals. The demersal fish forms (flounders, soles, cods, redfish), are probably the most fully exploited groups in terms of their total potential. The Indicative World Plan Working Group on Marine Resource Appraisal (1966) concluded that there are no large demersal fish stocks left unexploited in the Northeastern Atlantic. In view of the rapid expansion of trawl fisheries in the Eastern Pacific and the historically heavily exploited Asian stocks of demersals, one can hardly expect a general increase in production of demersal fish in the Northern Hemisphere. This does not, however, preclude further development of local stocks in the Gulf of Alaska, the Gulf of Mexico, and several other areas. Very recent egg and larvae research suggests, however, that even in the North Atlantic very large populations of sand lance and blue whiting are being exploited at very low proportions of their potential yield.

The Southern Hemisphere does have underutilized demersal stocks, particularly in the waters off both coasts of South America and New Zealand, and further development will occur off West Africa. This is tempered, however, by the fact that nearly 70 per cent of the Continental Shelf areas of the world lie in the Northern Hemisphere, and most of these areas are rather intensively exploited. As a rough estimate, we might assume that demersal fish stocks are now providing about 60 to 80 per cent of their total potential, given present techniques and market preferences. The ultimate potential may be much greater.

Pelagic fish stocks (tuna, sardines, jacks, anchovies, hakes, etc.), have considerable potential for increased production. As with demersal fish, utilization is now most intensive in the Northern Hemisphere, and the potential for growth is greatest in the Southern Hemisphere and in the Arabian Sea. It is extremely difficult to fix the degree of utilization of pelagic forms in realistic terms, but obviously only a small percentage of the biological potential of pelagic fishes is being utilized, perhaps less than 5 per cent.

Of the major shellfish and invertebrates, clams have been little touched. Oyster stocks are under considerable pressure, but shrimp, despite very strong market demands, are still capable of supporting much greater production.

If we look beyond present forms of fish considered marketable and present areas considered capable of supporting economically profitable operations, the following considerations are relevant. Most of the world catch of marine fish comes from waters over the Continental Shelf at depths less than 200 fathoms. Only about eight per cent of the surface area's of the oceans may be classified as shelf areas. The remaining 92 per cent encompasses the continental slopes and deep basin regions. It is estimated by Bogdanov (1966) that about 90 per cent of the world's catch is taken from the small area defined as continental shelf waters. As might be expected, on economic grounds, man's fishing efforts are centered on regions which are most accessible and where environmental conditions operate to concentrate fish.

On a per unit basis, waters beyond the shelf are producing only one-eightieth as much as the shelf waters. The productivity of mid-ocean waters, at least of the forms now most useful to man, would be expected to be lower than over the shelf, of course. Very large parts of the high seas have primary productivity less than one-fifth that of the present fishing areas, and in many cases it is less than one-tenth. *No* primary production occurs below a depth of about 150 meters. Nevertheless, the degree of utilization in the open oceans is even smaller than the expected availability of fish.

There are great quantities of squid, lantern fishes, pomfrets, bristle mouth, jacks, tuna-like fishes, etc., which inhabit open ocean regions, but effective utilization of many of these will call for development of new harvesting technology. Perhaps as much as 40 to 60 per cent of estimated biological potential is tied up in fish and shellfish inhabiting the open oceans. If fishing systems were stabilized at present efficiency levels there would be little hope of really major increases in the harvest of pelagic fishes in the open oceans (and of some pelagic forms which overlie the shelf as well). There are, however, some underutilized and unused fish stocks which are available for harvest with conventional gears. Such potentials are available in varying degree in almost all areas of the world.

Present knowledge is admittedly not very definitive as to the areas and resources that will supply future catches. At the moment it seems likely that continued fisheries growth over the next decade will come largely from continued geographic expansion. Production will increase in the Southern Hemisphere as a result of greater efforts to utilize the hakes and sardine-like fish off Africa and the East and West coasts of South America, and pelagic fishes off New Zealand and Australia.

There will be some expansion in demersal fisheries from these same waters, but the increase, relative to current production, will not be large. In the Indian Ocean (Arabian Sea) there is apparently a good possibility of expanding pelagic fish catches and in the Northeastern Pacific further increases in flounder catches are likely.

The following species and areas appear to have the greatest growth potential contingent on existing technology:

- –Herring-like fishes. Arabian Sea, California, Chile, Argentina, Gulf of Alaska, Gulf of Mexico, Venezuela, Northern Brazil, West Africa
- –Hakes. Chile, Peru, Mexico, Argentina, West Africa
- –Clams. Worldwide
- –Flounders. Northeast Pacific, Patagonian Shelf, New Zealand
- –Tuna and jacks and some saury. New Zealand, Australia, Mid-Pacific, Atlantic.

If we anticipate continued development of our ability to locate, concentrate, and harvest, the following marine forms might provide major increases in production:

- –Squids
- –Clams
- –Pelagic ocean fishes, such as bristle mouth, saury, tuna, jacks, and pomfrets
- –Redfish
- –Smelts and herring-like fishes
- –"Deep sea" forms–(500-2,000 meters) (e.g., rattails).

This discussion has been limited to fish and shellfish, but we should not overlook the likelihood that man may evolve extractive processes which will allow him to move further down the food chain. Soviet scientists and technologists working on the harvest of krill in the Antarctic regions estimate a potential annual production ranging upward from 100 million metric tons. A similar product forms the basis for a large part of the fish sauce used extensively in Southeast Asia and Japan. A breakthrough which makes it economically possible to harvest forms lower in the food chain would greatly alter concepts of ocean food potentials. Similarly, greater efforts to harvest bivalves which also feed on sources close to primary production would greatly increase ocean yields.

Full use of natural potential does not preclude the possibility of increased production through environment control and extensive marine culture. As yet, however, these types of productive effort are limited in scope, and even in Japan they have been concentrated almost entirely on high-valued luxury items with relatively low production and in estuarine areas.

The pace of science has tended to make all forecasts in the natural resources area unduly pessimistic in retrospect, and the same may be true in the ocean fisheries field. Nevertheless, it is a hard fact that most of the unused and underutilized protein potential from the sea is distributed over vast areas in extremely low concentrations. In many respects the technological task of using these resources–location, concentration, and low-cost processing of large masses–is quite similar to the job facing the potential user of minerals from the sea, except that the mobility factor makes it even harder to utilize fish resources efficiently.

If man is to take the largest remaining step in harvesting the living organisms of the sea he must first make some very large preparatory jumps at the scientific and engineering levels.

IV. THE NATIONAL FISHERIES

A. Demand

The Economics Division of the Bureau of Commercial Fisheries is now undertaking detailed analysis of factors affecting the demand for fish, from which more reliable long run forecasts can be made. At the moment, it is possible to indicate only in general terms what these factors are and the direction of change in demand each may be expected to induce.

The following major factors determine total national demand for fish:

- –The level of personal income per capita
- –Aggregate size of the population

–Dietary habits of specific groups for whom religious customs and differences in national origin affect per capita consumption of fish

–Price, availability, and relative quality of closely substitutable products, of which meat and poultry are much the most important

–Tastes and preferences, including the relative importance attached by consumers to shopping convenience and ease of storage and preparation as opposed to nutritive value or flavor of the fish itself.

1. Per Capita Income

Overall direct consumption of fish in the United States does not appear to be affected significantly by changes in per capita income, but this aggregate stability conceals wide differences in the sensitivity of species to rising consumer income. As would be expected, the strongest influence of income on demand for fish products centers on: high-valued species with particularly desirable flavor and texture; species that lend themselves to relatively easy and convenient preparation, particularly those that can be sold in packaged fillet and stick form; and shellfish. Fin fish of lower quality, particularly those that are not suitable for filleting and freezing, are likely to show zero or even negative response to income changes, as lower income consumers who take the bulk of these fish shift to more desirable sea foods and to meat and poultry with rising income.

2. Population: Size and Ethnic Composition

Population increase should have a nearly linear effect on the demand for fish, with some modification to reflect changes in the relative weight of groups whose national origin or religious practices create a special demand for fish products.

This latter modification may have a slightly negative effect on the demand for fish products in the United States. Immigrants from countries where large amounts of fish are consumed tend to eat more sea food in this country as well, but this influence dies away as succeeding generations drift into more conventional American consumption patterns. It is also possible that the newly authorized modification of dietary restrictions on Catholics with respect to eating meat may influence the demand for fish products, but the direction of change is not clear. Presumably, Friday purchases of fish will be reduced, but this may well be offset by increasing consumption on other days of the week, not only among Catholics but among others as well. Neither effect appears strong enough to modify significantly the conclusion that aggregate demand for fishery products as a whole would follow closely changes in the aggregate size of the population.

3. Substitutes

Over the next 10 to 15 years, the price and availability of the principal substitutes for fish—meat and poultry—are expected to be highly favorable; this will act as a damper on the demand for fish products. The most authoritative forecast of prices of meat, poultry and other foods, Landsberg et. al. (1963), points out that while the recent technical revolution in poultry production has largely run its course, some continued downward movement in prices can be expected, and there is no reason to anticipate a subsequent increase. Similarly, they forecast a gradual bottoming out of prices at lower levels for the majority of U.S. red meat sources. For fish products consumed directly, the "ceiling" imposed by the dominant red meat and poultry segment of U.S. protein food supplies will continue to be a fairly tight one for the next two decades. This does not apply to fish meal, however, since it is an important input for the poultry, dairy, and meat industries.

4. Tastes and Preferences

The most striking change in the national market for fish products has been the shift toward freezing and packaging (a trend affecting many other perishable foods). It is unlikely, however, that these trends will affect the total demand for fish appreciably; they represent essentially changes in consumer preferences for processing and marketing components of the final product, and their impact on the demand for raw fish involves a change in species composition (and perhaps in quality requirements) rather than a net addition to consumer usage.

On balance, then, it would appear logical to assume that direct per capita consumption of edible fish products would remain stable in the vicinity of the 9 to 11 pounds per year (edible weight) that has prevailed over a long period, with shift factors roughly offsetting one another. On this basis, total edible fish consumption should increase at approximately the same rate as population, with greater increases in the demand for relatively high valued species and those that lend themselves to convenient storage and pre-preparation. This is the conclusion reached by Landsberg, Fischman, and Fisher, and it parallels a similar analysis of demand for fish products in Canada conducted several years ago by W. C. MacKenzie (1961).

The forecast of national demand for industrial fish products is much more favorable. The major items will continue to be fish meal and oil, both of which are still reaching new users and cutting into the markets of competing products. Since meal and oil are sold on a highly competitive world market, however, the U.S. competitive position must be improved if it is to share in growth of the domestic market.

A second range of possibilities for expansion has been opened up by the development of fish protein concentrates for human consumption. This exciting new facet of the fishing industry is discussed in detail later. At this point, the panel simply notes that the technological problems of producing an acceptable product are well along toward solution, and it is believed that plants now in the planning stage will be able to produce fish protein concentrate at or below the critical cost level. While the peculiar marketing difficulties associated with dietary supplements of this type must still be resolved, the future appears bright for fisheries whose catches can be converted into fish protein concentrate. The basic experimental work was conducted with lean white fish (hake) but there is no reason to doubt that a wide range of other species not otherwise marketable can be used with the same process.

Demand for fish protein concentrate from both national and international governmental sources should grow to substantial proportions given the keen interest in world nutritional problems. Over the long run, however, the necessity of using bulk supplies of very cheap fish and the pressure to promote local industry in underdeveloped areas suggest strongly that the American share of total fish protein concentrate production will fall, though the absolute level may continue upward even after world production begins to expand.

It should be noted that U.S. demand for fishery products is highly selective, with a strong preference for relatively high priced fish and shellfish. Eight species groups of the 55 taken in commercial quantities by U.S. fishermen account for 80 per cent of the total catch value; seven of these would be considered high valued items, and the other—menhaden—is used largely for meal and oil (much of which end up as poultry, meat, or dairy products). Shrimp, salmon, and tuna alone account for nearly 50 per cent of the total landed value of the United States fisheries.

The sheer magnitude of the total U.S. demand for fish and shellfish is startling. By 1967 con-

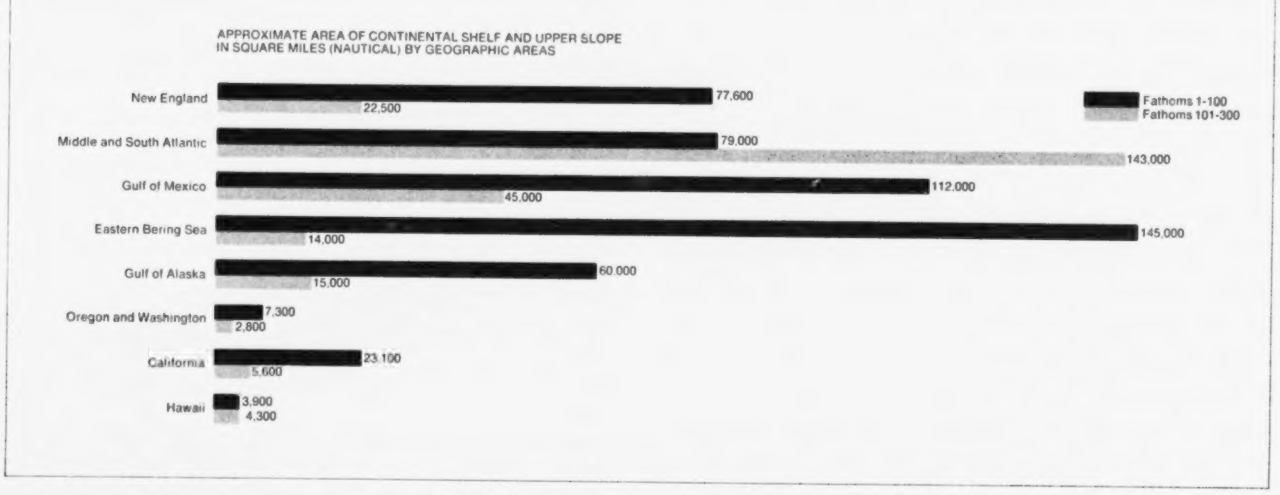


Figure 2. *Approximate area of Continental Shelf and upper slope in square miles (nautical) by geographic areas.*

sumption had reached about 14 billion pounds—nearly 12 per cent of total world production—and per capita consumption (including that used for oil, meal, and other industrial purposes) was about double the world average. The United States has become the largest market for marine fish and shellfish in the world and growth continues.

Clearly, the failure of U.S. sea fish production to expand over the first three decades cannot be attributed to lagging demand.

B. Production Possibilities for U.S. Flag Fisheries

Most of the fish taken in North American waters are caught on or over the Continental Shelf areas. The character of the Outer Continental Shelf adjacent to various segments of the United States and the extent of shelf areas involved therefore play a major role in determining the level and composition of the United States fishing industry. Figure 2 provides an approximation of the Continental Shelf areas in square miles (nautical) adjacent to major subdivisions of the United States. It is apparent that the extensive shelf areas adjacent to our country are mainly in the Bering Sea and Gulf of Mexico, with moderately extended shelf areas in the central Gulf of Alaska and off the New England States.

1. Scope of Existing U.S. Shelf and High Seas Fisheries

The general dimensions of the American fishing industry are indicated in Tables 5, 6, and 7 and Figures 3 and 4. For detailed summaries of production and historic trends for major United States fisheries, readily accessible and authoritative sources are presented in Graham (1968) and Ketchan (1968).

Several essential characteristics of the United States flag fisheries stand out clearly in these data. Most apparent is the absence of growth; landings have been virtually stable at between four and five billion pounds for the past three decades. Meanwhile, world production of fish and shellfish has climbed from about 20 million metric tons in 1950 to 57 million tons in 1966. U.S. consumption has also expanded rapidly, from about 44 pounds (round weight equivalent) in 1950 to 72 pounds in 1967, but the entire gross increase has been met from imports. The relative decline in the position of the U.S. fleet has been even greater with respect to landings used directly for human food.

It is also evident that there are major differences in the regional composition of catches. New England landings consist largely of ground fish and shellfish entering the fresh and frozen trade. High valued salmon, tuna, crabs, and oysters dominate the catch in the Pacific Coast States; groundfish assumed much greater importance after 1940, but have levelled off in recent years. Catches in the Mid-and South Atlantic and Gulf areas are dominated in terms of volume by landings of industrial fish (principally menhaden) used for meal and oil, but also produce large quantities of valuable shrimp, oysters and crab for the fresh and frozen market. The inshore fisheries of Hawaii are very small and stable; the bulk of the catch, by weight and value, comes from the tuna operation.

The fisheries of the United States as a whole are heavily oriented to species taken on or above the

Table 5
U.S. CATCH OF FISH AND SHELLFISH, 1945-1967

Year	Landings (millions of pounds)	Value (millions of dollars)
1945	4598	270
1946	4467	313
1947	4349	312
1948	4513	371
1949	4804	343
1950	4901	347
1951	4433	365
1952	4432	364
1953	4487	356
1954	4762	359
1955	4809	339
1956	5268	372
1957	4789	354
1958	4747	373
1959	5122	346
1960	4942	354
1961	5187	362
1962	5354	396
1963	4847	377
1964	4541	389
1965	4777	446
1966	4366	472
1967 (preliminary)	4006	440

Source: *Fishery Statistics of the United States, 1965,* U.S. Department of the Interior, 1967, p. 19; current figures from the Bureau of Commercial Fisheries.

Table 6
SUMMARY OF CATCH, 1967[1]

Region	Fish (millions of pounds)	Shellfish, etc. (millions of pounds)	Whale products (millions of pounds)	Value to fishermen (millions of dollars)
New England	566	59	–	70
Middle Atlantic . . .	95	62	–	23
Chesapeake	303	120	–	35
South Atlantic . . .	282	65	–	25
Gulf	861	276	–	126
Pacific	880	245	7	140
Great Lakes	80	–	–	6
Mississippi River & tributaries . . .	57	43	–	12
Hawaii	12	[2]	–	3
Total	3,136	870	7	440

Source: U.S. Department of the Interior, Bureau of Commercial Fisheries.

[1] Preliminary.

[2] Less than 500,000 pounds.

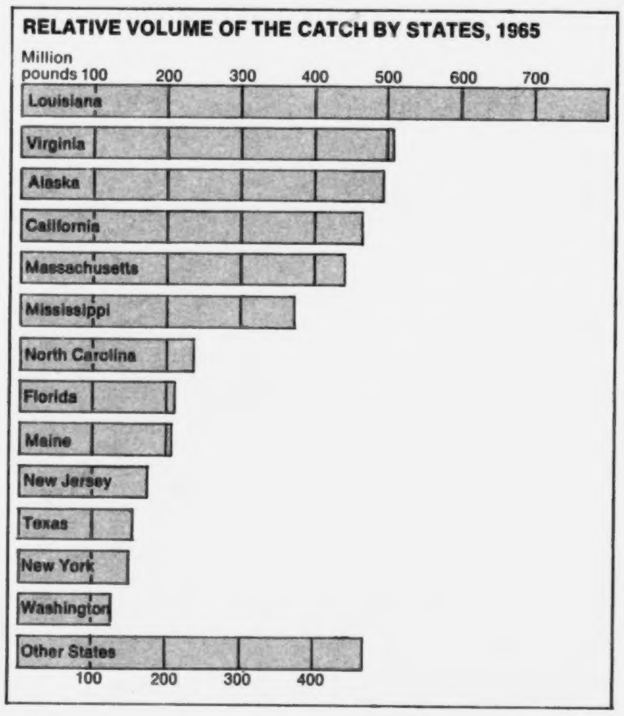


Figure 3. *Relative volume of the catch by States, 1965. Source: Bureau of Commercial Fisheries, Department of the Interior.*

Continental Shelf. It is estimated that total non-shelf production accounts for no more than 10 per cent by weight and 15 per cent by value, most of it consisting of tuna and tuna-like species.

As indicated in Table 8, direct employment in the United States marine fisheries was only about 133,000 in 1967 and a large, though unknown, proportion of these fishermen are only part-time participants. The number of fishermen has declined since 1950, as a result of a slight but persistent tendency toward larger and more capital-intensive fishing units with a stable total catch.

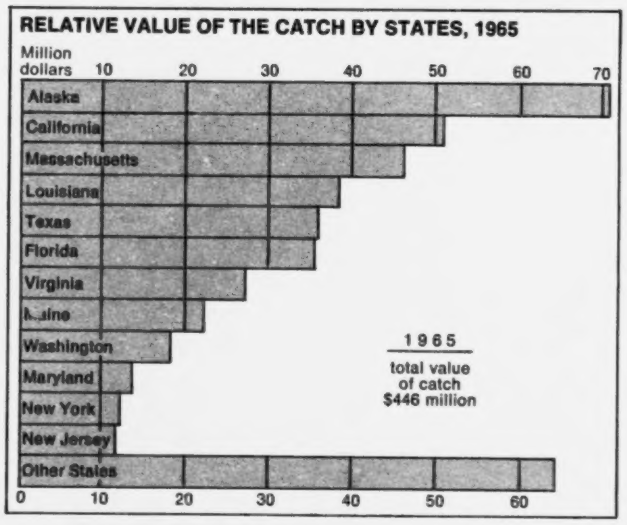


Figure 4. *Relative value of the catch by States, 1965. Source: Bureau of Commercial Fisheries, Department of the Interior.*

Table 7

UTILIZATION OF FISHERY PRODUCTS IN THE UNITED STATES FOR SELECTED YEARS, 1945-1967

	1945	1950	1955	1960	1965	1967
Population, Millions[1]	129.1	150.2	162.3	178.2	191.9	195.7
	Edible Fish (round weight)					
Domestic catch, million pounds	3,167	3,307	2,579	2,498	2,586	2,385
Imports, million pounds	680[3]	1,128	1,332	1,766	2,576	2,683
Total, million pounds	3,847	4,435	3,911	4,264	5,162	5,068
Per capita use, pounds	29.8	29.5	24.1	23.9	26.9	25.9
(meat weight)[2]	(9.9)	(11.8)	(10.5)	(10.3)	(10.9)	(10.6)
	Industrial Fish (round weight)					
Domestic catch, million pounds	1,431	1,594	2,230	2,444	2,190	1,677
Imports, million pounds	31[4]	639	980	1,515	3,182	7,442
Total, million pounds	1,462	2,233	3,210	3,959	5,372	9,119
Per capita use, pounds	11.3	14.9	19.8	22.2	28.0	46.6
	Total Fish (round weight)					
Domestic catch, million pounds	4,598	4,901	4,809	4,942	4,776	4,062
Imports, million pounds	711	1,767	2,312	3,281	5,758	10,125
Total, million pounds	5,309	6,668	7,121	8,223	10,534	14,187
Per capita use, pounds	41.1	44.4	43.9	46.1	54.9	72.5

Source: Office of Program Planning, Bureau of Commercial Fisheries.

[1] July 1 population eating from civilian supplies, excluding armed forces overseas: beginning 1950—50 States.

[2] Computed per capita consumption on edible or meat weight basis with allowances for exports and changes in beginning and end-of-year stocks.

[3] Estimate based on 1946 relationship of round to imported product weight.

[4] Estimate based on the 1946 ratio of round weight to industrial product weight.

Table 8
NUMBER OF U.S. FISHERMEN BY REGION

Region	1966	1967[1]
New England	18,518	18,043
Middle Atlantic . . .	8,686	8,413
Chesapeake	18,810	18,225
South Atlantic . . .	10,594	10,500
Gulf	25,309	25,350
Pacific (Washington, Oregon, and California)	21,759	21,600
Hawaii	744	699
Alaska	19,412	18,172
Great Lakes	2,118	2,000
Mississippi River and tributaries . . .	15,367	15,100
Total (exclusive of duplication) . . .	135,636	133,102

Source: U.S. Department of the Interior, Bureau of Commercial Fisheries.

[1] Preliminary.

2. Potential Production

Alverson (1968), Ahlstrom (1968), Bullis (1968), and Edwards (1968) provide the most current published estimates of the potential resources adjacent to various geographic sections of the United States.

a. New England Edwards (1968) estimated that total standing stock of demersal fishes adjacent to New England states was in the vicinity of 11,877 x 10^6 pounds and that 95 per cent of this standing stock is made up of 27 species (Table 9). The 1963-65 yield from these fishes was approximately 2,630 x 10^6 pounds, but the United States catch constituted only about 30 per cent of the total. It does not appear that demersal fish catches can be greatly increased in this area. In addition to the demersal fishes of the region, Edwards also suggested that the standing stock of squids is in the order of 700 million pounds and that there may be 50 million pounds of lobsters on the shelf adjacent to New England. Estimates of the potential yield for latent species are given in Table 10.

United States landings from the area were valued ex-vessel at $68 million in 1964 and $75 million in 1965.

b. Mid- and South Atlantic and Gulf of Mexico Bullis (1968) has made estimates of the latent yields of fish and shellfish that might be expected from the Gulf of Mexico and the southeast Atlantic coast of the United States (Table 11). The Gulf of Mexico is believed to have one of the largest latent fisheries potentials of any area adjacent to the United States; Bullis foresees possible annual production in the order of 21.021 million pounds. Potential yield from the middle and south Atlantic seaboard of the United States is estimated at about 11.434 million pounds. Bullis's figures, which also cover current levels of production by U.S. fishermen, suggest that the present use rate of fisheries resources off the middle and southeast seaboard of the United States and in the Gulf of Mexico is a small fraction of the potential. U.S. landings in 1964 and 1965 were valued at $177 million and $206 million.

c. Pacific Northwest (Oregon to Alaska) Pacific Northwest catches are dominated, in poundage and value, by several high-valued species already exploited rather fully: salmon, halibut, crabs, and oysters. Demersal species, particularly in the Gulf of Alaska and the Bering Sea are very lightly fished by United States vessels.

Alverson (1968) provides authoritative data on fisheries potential of the Pacific Northwest. His estimates of the standing stocks and maximum sustainable yield for the 10 most important demersal fishes found in this region are shown in Tables 12 and 13. Current production of demersals from this region by all nations is in the order of three billion pounds. However, most of this total is harvested by foreign fishermen (mainly Russian and Japanese) in the Bering Sea and the Gulf of Alaska. U.S. production of demersal fishes in the Pacific Northwest accounted for only about 150 million pounds of the total. In addition to demersal fish, Alverson sees a potential catch of shrimp from the Gulf of Alaska and Bering Sea of 200 to 300 million pounds. The potential for crabs (king, tanner, and Dungeness) appears to be on the order of 250 million pounds. King and Dungeness stocks are rather fully exploited at present, but tanner crabs are barely touched.

The extent of pelagic fish resources of the Gulf of Alaska, Bering Sea, and off Oregon and Washington is not well known. Herring appears to be the dominant overshelf pelagic fish now under exploitation. There are large stocks of squid, pomfret and saury in the region, but they are

Table 9

ESTIMATED STANDING STOCK IN DECREASING ORDER AND AVERAGE ANNUAL CATCH FOR THE PERIOD 1963-1965 (NEW ENGLAND AREA)

(to nearest million pounds)

	Standing Stock	Average Annual Landings	Average U.S. Annual Catch (1963-1965 excl.)	Percentage of Catch to Standing Crop
Silver hake (Whiting). . . .	2,084	638	83.2	30.6
Sea herring	1,824	529	97.6	29.0
Spiny dogfish (Grayfish) . .	1,373	+	00.4	
Haddock	980	337	130.4	34.4
Red hake	694	176	3.7	25.4
Pollock	596	54	13.2	9.1
Thorny skate[1]	579			
Cod	489	156	37.8	31.9
Ocean perch	399	54	30.0	13.5
Little skate[2]	386			
Butterfish	309	10	3.5	3.2
Big skate[2]	295	+		
Argentine[3]	187	9		4.8
Blackback	185	32	18.7	17.3
Yellowtail	185	93	78.0	50.3
Barndoor skate[2]	178	+		
Eel pout[3]	171	12		7.0
Goosefish[3]	142	+		
American plaice (Sea dab) . .	125	9	6.2	7.2
Alewife	87	42	10.4	48.3
White hake	72	7	6.4	9.7
Longhorned sculpin[3] . . .	71	+		
Sand flounder (Fluke)[2] . . .	68	+		
Scup	66	+		
Grey sole	32	4	3.4	12.5
Fourspot flounder[2]	16	+		
Sea raven[3]	10	+		
All others	308	460[1]		
Totals	11,877	2,630	597.1	22.1

[1] This poundage includes all species, especially those landed but not recorded separately by various food fisheries and the industrial fishery. Only a small part of this figure represents species not listed in table.

[2] Not broken down in U.S. Fishery Statistics.

[3] Not available in U.S. Fishery Statistics.

Table 10
ESTIMATED SUSTAINED CATCH CAPABILITIES FOR VARIOUS LATENT OR LARGELY UNUSED FISHERY RESOURCES NEW ENGLAND AND MIDDLE ATLANTIC AREAS[1]
(millions of pounds)

	Estimated Catch Potential by Areas		Estimated Annual Potential Catch Total
	ICNAF[2] Subarea 5	Middle Atlantic	
Flyingfish	6.6	11.0	17.6
Grenadiers	40.0	11.0	51.0
Anchovies	6.6	15.0	21.6
Sand Launce	6.6	2.2	8.8
Bluefin tuna	15.0	4.4	19.4
Yellowfin tuna	–	11.0	11.0
Skipjack	55.0	22.0	77.0
Little tuna and others	2.2	2.2	4.4
Swordfish	4.4	2.2	6.6
Sharks	77.0	66.0	143.0
Invertebrates			
Northern shrimp	55.0	–	55.0
Red crabs and others	2.2	2.2	4.4
Ocean quahogs	11.0	114.0	125.0
Surf clams	5.0	85.0	90.0

[1] Estimates courtesy Keith A. Smith.

[2] International Commission for Northwest Atlantic Fisheries.

virtually unused. Perhaps the largest unknown potential in the Pacific Northwest region is that for mollusks. Very large quantities of clams known to inhabit the inter-and subtidal areas in the waters of this region. There is no information, however, upon which to quantify their potential. Perhaps more important, the recurrent toxicity of these shellfish in Alaska waters makes it impossible to market them at present.

The utilization of the extensive butter clam resource in Southeastern Alaska has been restricted since 1946 when the U.S. Food and Drug Administration found that the clams may contain a naturally occurring toxic substance, identical to that sometimes found in mussels in California. The toxin is derived most commonly from a dinoflagellate plankton, *Gonyaulax catenella.* Frequently, but not always, these plankton produce endogenously a potent neurotoxin that is retained by the butter clams in the areas of occurrence. Since these episodes cannot be predicted, except in a general way, clams from Alaska beaches must be sampled and analyzed at the time of harvest to assure a safe product. The extensive Alaska butter clam resource cannot be utilized on a large scale economically until the problem of monitoring the toxin occurrence at time of harvest is solved. Alternatively, practical methods of processing or treating the clams to eliminate the toxin at point of harvest might be developed and enable utilization.

The 1964 and 1965 values to American fishermen in this region were $134 million and $167 million.

d. California The Continental Shelf area off California is relatively narrow and the potential yield of demersal fishes relatively small. It will

Table 11

1967 CATCHES AND LATENT FISHERY RESOURCE POTENTIALS OF THE GULF OF MEXICO AND SOUTHEASTERN ATLANTIC COAST OF THE UNITED STATES

(millions of pounds)

	Gulf of Mexico		U.S. Atlantic Coast South of Cape Hatteras		Total		Expansion	Species of Greatest Potential
	1967 Catch	Estimated msy[1]	1967 Catch	Estimated msy[1]	1967 Catch	Estimated msy[1]		
Coastal Pelagic fish . . .	1,064	8,337	222	2,881	1,286	11,219	9x	Herring Sardine Anchovy
Bottomfish (industrial) . .	88	4,852	9	3,611	97	8,463	87x	Croaker Spot Sea trout
Bottomfish (food) . . .	54	1,211	18	278	72	1,489	21x	Snapper Grouper
Midwater fish	none	2,148	1	91	1	3,120	100x+	Butterfish Bumper, Scad Harvestfish
Shellfish	257	3,807	80	3,480	337	7,287	22x	Scallops, Squid Lobsters, Crabs Shrimp
High Seas Pelagic fish . .	none	893	1	1,096	1	1,989	100x+	Sharks, Tuna Flyingfish Dolphin
Total	1,463	21,248	331	11,434	1,794	33,567	17x	

[1] Maximum sustained yield.

Table 12
ESTIMATED STANDING STOCKS FOR THE 10 MOST ABUNDANT DEMERSAL FISHES IN THE NORTH PACIFIC
(thousands of tons)

Species	Transition Zone[1]	Gulf of Alaska[2]	Bering Sea[3]	Total
Yellowfin sole	—	8	2,000	2,010
Walleye pollack	60	130	1,500	1,690
Pacific ocean perch	860	370	150	1,380
Rock sole	30	115	1,225	1,360
Arrowtooth flounder . . .	180	435	200	815
Pacific hake	750	—	—	750
Spiny dogfish	450	25	—	475
Flathead sole	—	145	200	345
Pacific cod	45	80	140	265
Dover sole	120	80	5	205

[1] Oregon to Cape Spencer Alaska.
[2] Cape Spencer to Univak Pass.
[3] All waters of Eastern Bering Sea.

Table 13
ESTIMATED SUSTAINABLE YIELDS (OREGON TO BERING SEA) FROM THE 10 MOST ABUNDANT COMMERCIALLY USABLE DEMERSAL FISH AND HARVEST LEVEL FOR SPECIFIED YEARS
(thousands of tons)

Species	Estimated Maximum Sustained Yield	Catch (highest)	Year	Catch High Five Consecutive Years (average)	Years	Catch 1966
Yellowfin sole . . .	201-401	550	1961	340	1959-1963	140
Walleye pollack . .	169-338	260	1966	130	1962-1966	260
Pacific ocean perch .	138-276	470	1965	271	1962-1966	315
Rock sole	136-272	8	1964	4	1962-1965	8
Pacific hake . . .	150-270	175	1967	150	1966-1967 (only)	130
Arrowtooth flounder	82-164	39	1964	22	1962-1966	18
Flathead sole . . .	35-70	11	1964	9	1962-1966	5
Dover sole	21-42	9	1963	7	1960-1964	4
Pacific cod	27-54	42	1966	27	1962-1966	4
Spiny dogfish . . .	20-30	67	1944	37	1941-1945	4

probably not exceed 150 million pounds. Pelagic fishes, on the other hand are abundant in the offshore waters. Ahlstrom (1968) indicates an anchovy population in these waters in the order of 4 to 5 million tons, from 1.4 to 2.4 million tons of jack mackerel, and 2 to 4 million tons of hake. In addition he feels that there are large stocks of saury in the offshore waters and forecasts a standing stock of at least 450,000 tons of this species. California waters also abound in squids and other small pelagic species. The extent of clam populations is not well documented. There are fair quantities of Dungeness crabs in the shallow waters inside 50 fathoms off California, but these populations are probably being harvested at their maximum level at the present time. Current catches of the major species of fish and shellfish taken off California are given in Table 14. United States fishermen received $50 million in both 1964 and 1965; about $35 million each year represented values for non-shelf species (tuna and tuna-like fishes).

e. Hawaii The potential of demersal fishes in the Hawaiian Island area is now being investigated. In recent years there has been increasing interest in the possibilities of harvesting penaeid shrimps from these waters. There are no data available on which to quantify these potentials at the present time. Large stocks of pelagic fish, particularly tuna, do occur in waters adjacent to the Islands, but most of these inhabit waters well beyond the outer limits of the Continental Shelf. In 1964-1965, for example, about 80 per cent of landings in Hawaii consisted of tuna, and these species accounted for about $2 million of the total landed value of $2.8 million in 1964 and $2.7 million of the 1965 total of $3.6 million.

f. Overall Production Potential Total United States fish and shellfish production in recent years has fluctuated between four and five billion pounds with an annual ex-vessel value of about $420 million. It is apparent from the works of Graham (1968), Ketchen (1968), and Edwards (1968) that considerable quantities of fish are harvested on the Continental Shelf adjacent to the United States by foreign fishermen. When this production is also considered, the total yields from over the Continental Shelf adjacent to the United States probably approach 10 billion pounds with an estimated value in the order of $605 million. While it is not certain that United States fishermen will ultimately capture any great share of the production now being taken by foreign fishermen, it must be considered in evaluating the resources currently extracted from the shelf areas of the United States.

It would appear from the work of the various authors noted above that the ultimate potential of fisheries resources overlying the Continental Shelf off the United States is in the order of 50 billion pounds or roughly 10 times present United States production. Much of this would be very low valued, however, and much of it cannot be harvested profitably using present fishing techniques and conventional end products.

3. The Great Lakes Fisheries

These fisheries are discussed separately, since they are operated in an environment entirely different than that of the sea. Though they have never approached the major sea fisheries in tonnage, they were, for a long period of time, dominated by relatively high valued species, and the resulting economic contribution was by no means negligible. In addition, the Great Lakes offer an important and in some respects unique set of recreational opportunities, including sport fishing, to the tremendous population within easy driving distance (perhaps 25 per cent of the entire population of the United States). The management of the living resources of the Great Lakes is therefore a matter of national concern.

a. Present State of the Fisheries The sad state of the American commercial fisheries of the Great Lakes stands out clearly in the figures of Tables 15-18. During the early flush days of the Great Lakes fisheries, from 1897-1908, U.S. landings averaged 102.3 million pounds. By the 1914-1928 period, U.S. landings had dropped to 85.3 million, and from 1929-1963 they averaged only 75.9 million. The total U.S. catch in 1963 was the lowest on record--55.8 million pounds--and the subsequent sharp increase in 1966 and 1967 resulted only from a very large increase in the harvest of alewives (an extremely low-valued species). Total landings have held up much better, of course, since Canadian catches have increased.

Table 14
CALIFORNIA FISHERY: AVERAGE YEARLY CATCH OF FISH AND SHELLFISH BY CALIFORNIA FISHERMEN, BASED ON FIVE YEAR AVERAGE VALUES FOR 1955-1960, 1961-1965, AND 1966
(thousands of pounds)

Fish and Shellfish	Average Yearly Catch 1955-1960	Average Yearly Catch 1961-1965	1966 Catch
Tuna and tuna-like fishes			
Albacore	35,030	36,020	18,190
Bluefin	18,230	24,310	34,820
Bonito	2,030	4,580	19,150
Skipjack	95,660	81,010	51,090
Yellowfin	141,600	146,210	132,595
Yellowtail	310	170	245
Pelagic wetfishes			
Anchovy	24,210	5,130	62,280
Herring	1,770	840	240
Jack Mackerel	58,460	87,900	40,975
Pacific mackerel	42,700	33,360	4,515
Sardine	90,940	16,120	880
Squid	12,320	13,260	19,025
Bottom fishes			
Flatfish	18,940	20,410	22,145
Hake	1,020	90	70
Ling cod	1,360	1,070	800
Rockfish	15,480	9,980	10,060
Sablefish	2,220	2,150	3,215
Other fin fishes			
Barracuda	940	510	320
Salmon	6,710	8,460	9,445
Shad	180	0	0
Sharks and skates	900	880	795
Smelts and white bait	700	600	685
White croaker	960	820	790
White sea bass	2,020	1,000	1,340
All others	1,910	3,880	4,505
Crustacea and mollusca			
Abalone	4,550	4,340	4,915
Crab	16,660	4,900	12,675
Oyster	10,320	5,000	800
Shrimp	1,820	1,690	1,230
Spiny lobster	570	490	485
Others	30	40	20
Total fish and shellfish	610,550	515,220	458,300

Table 15
GREAT LAKES CATCH, 1879-1967[1]
(thousands of pounds)

Year	United States	Canada	Total
1879	66,891	9,347	76,238
1890	111,550	28,646	140,196
1903	94,185	18,839	113,024
1920	73,168	31,680	104,848
1930	87,412	28,354	115,765
1940	76,588	21,770	98,358
1950	68,906	26,502	95,408
1960	65,936	37,918	103,854
1961	67,140	45,368	112,508
1962	61,850	53,534	115,384
1963	55,823	42,794	98,617
1964	53,559	34,045	87,604
1965	54,156	43,579	97,735
1966	67,726	47,813	115,539
1967[2]	78,300	41,500	119,800

Source: U.S. Department of the Interior, Fish and Wildlife Service, *Fishery Statistics of the United States, 1963* and *1965;* current figures from Bureau of Commercial Fisheries.

[1] The above data do not include the international lakes.

[2] Preliminary.

Far more disturbing are the changes that have occured in the composition of the landings. The traditional high-valued lake trout, whitefish, blue pike, and walleye have declined drastically relative to the total. The only species for which increases were recorded were the low-valued species, such as chubs, carp, yellow perch, and alewives.

b. Causal Factors No one factor can be singled out as *the* cause of the decline of the Great Lakes fisheries. It is actually attributable to a complex of problems, some of them inherent in the physical setting, some due to commercial pressures, and some due to inadequate public policy. In this section, a brief summary of the key developments is present. Detailed analyses may be found in Brouillard (1963); Beuttner (1963); Smith (1968).

One of the major sources of difficulty with the exploitation of living resources of the Great Lakes is the complex ecology of the region. The Great Lakes are relatively new bodies of water, and fish populations have not had sufficient time to develop into stable, organized systems making full use of the biological capacity of the lakes, as

Table 16
QUANTITY, VALUE, AND AVERAGE PRICE, U.S. GREAT LAKES FISHERIES, 1940-1966

Year	Quantity	Value	Average price
	(millions of pounds)	(millions of dollars)	(cents per pound)
1940	79.1	5.6	7.1
1945	78.6	13.8	17.6
1950	70.9	10.8	15.3
1955	76.8	9.7	12.6
1960	68.2	7.1	10.4
1961	70.6	7.0	9.9
1962	65.6	5.3	8.1
1963	69.0	5.3	9.0
1964	56.7	5.6	9.9
1965	55.9	5.8	10.4
1966	69.4	5.9	8.5[1]

Source: 1940 to 1959, Keith Brouillard, *Economic Review of the Great Lakes Commercial Fisheries, 1940-59,* U.S. Department of the Interior, Fish and Wildlife Service Circular L4L, Washington 1963; 1960 to 1966, *Fishery Statistics of the United States, 1966.*

[1] Preliminary.

Table 17
U.S. GREAT LAKES CATCH BY STATES, 1935-1963[1]
(Thousands of Pounds)

Year	New York	Pennsylvania	Ohio	Michigan[2]	Indiana[2]	Illinois	Wisconsin	Minnesota	Total
1935	1,475	3,271	25,191	30,621	435	1,300	16,330	8,390	87,011
1940	1,970	2,295	18,996	26,044	524	1,943	17,006	7,811	76,588
1945	2,281	3,514	22,172	23,960	54	1,621	19,044	4,768	77,413
1950	574	2,236	20,225	23,153	34	1,576	18,400	2,708	68,906
1955	2,079	3,056	20,388	25,438	13	1,521	20,196	2,516	75,207
1960	589	1,015	18,011	25,021	16	324	18,394	2,565	65,936
1961	897	1,286	15,810	24,535	14	340	21,925	2,334	67,140
1962	680	2,150	15,225	22,121	6	289	19,075	2,303	61,850
1963	502	1,412	14,223	20,326	6	285	16,916	2,153	55,823
1964	446	817	11,230	19,769	11	645	18,570	5,199	56,187
1965	442	515	11,528	19,748	7	180	20,124	3,361	55,905
1966	457	573	10,516	21,284	–	303	32,822	3,409	69,364
1967	500	600	9,900	28,000	–	300	36,000	3,000	78,300[3]

Source: U.S. Department of the Interior; *Fish and Wildlife Service, Fishery Statistics of the United States, 1963* and *1965.*

[1] Data do not include the international lake.

[2] Beginning with 1944, the catch by Indiana fishermen in Michigan waters, is included with the production for the State of Michigan.

[3] Preliminary.

Table 18
U.S. GREAT LAKES CATCH OF SPECIFIED SPECIES, 1940-1966
(thousands of pounds)

Year	Blue pike	Chubs	Herring	Lake trout	Carp	White-fish	Yellow perch	Walleye
1940	5,073	2,411	22,480	9,859	5,998	4,678	6,451	6,072
1945	7,849	4,666	22,290	8,980	6,460	3,529	3,273	6,604
1950	6,236	9,413	17,454	3,255	4,209	5,270	4,851	7,856
1955	7,679	11,367	16,589	2,101	6,547	1,999	7,066	7,205
1960	12	16,853	11,111	384	7,343	830	10,238	1,798
1961	[1]	7,218	6,261	102	5,280	1,423	8,303	905
1962	1	14,428	10,050	258	7,646	1,027	12,024	852
1963	[1]	11,023	8,477	127	6,299	900	11,275	1,264
1964	[1]	7,218	6,261	102	5,280	1,423	8,303	905
1965	[1]	10,920	4,830	124	6,652	1,648	5,498	727
1966	[1]	9,992	4,576	120	7,263	1,972	6,164	752

Source: 1940 to 1959, Keith Brouillard, *Economic Review of the Great Lakes Commercial Fisheries, 1940-59,* U.S. Department of the Interior, Fish and Wildlife Service Circular L4L, Washington 1963; 1960 to 1966, *Fishery Statistics of the United States, 1966.*

[1] Less than 500 pounds.

would be expected in older bodies of water of comparable size and composition. As pointed out by Tanner (1965), the fish life in the Great Lakes, just prior to the appearance of the sea lamprey was relatively thin, with fragile and unstable relations among predators and their prey. As a result, the biological balance of the Great Lakes has been upset to an astonishingly large degree by a series of shocks; the introduction of exotic species, some from saltwater and some from fresh; man's own selective fishing activities; and the flagrant pollution and misuse of the coastal zones of the Great Lakes.

No other factor has done as much to damage the aggregate economic productivity of the Great Lakes fisheries as the invasion of the sea lamprey. Originally landlocked in Lake Ontario, this normally saltwater parasite found its way into the other Great Lakes through the Welland Canal. Water conditions in Lake Erie prevented any major destruction there, but when the lamprey moved into Lakes Huron, Michigan, and Superior, it expanded very rapidly with disastrous effects on some of the most valuable fish stocks in the lakes. The lamprey was particularly devastating to the lake trout, but it also attacked other valuable species, such as burbot and whitefish. Within a few years it had literally eliminated some of the major commercial fishing operations on the Great Lakes. An idea of the magnitude of its impact can be gleaned from the fact that the lake trout fishery, once valued at more than $4 million annually, had dropped to less than $100,000 in the 1960's.

The effect of the lamprey invasion spread even further. It led to greater concentration of fishing effort on the remaining valuable species, with serious effects on these populations and on the total stock of predators. Partly because of this, the alewife, another saltwater fish long known in Lake Ontario, suddenly exploded into phenomenal growth in Lakes Huron and Michigan about 1955. This latest intruder is unwelcome in several respects; it is not directly usable for human consumption and brings prices of only $15 to $20 per ton for fishmeal and oil or for pet food. More important, it is competitive with a variety of other species, for example, chubs, lake herring, and shiners. On the other hand, it serves as an excellent forage fish for trout and the recently introduced coho and chinook salmon. The success to date of these introductions may be due, in part, to the abundance of alewives.

It has been argued by some biologists that the dangerous instability of the Great Lakes fish populations will be increased by the tremendous dominance of the alewife. At present, it probably represents 90 percent of the total tonnage of fish in the Great Lakes. Greater stability and productivity might be achieved if a multiple species complex of prey and an appropriate balance of predators, both natural and human, could be re-established, but this remains a matter of disagreement.

The Commission's deep concern over the deterioration of water quality in the Great Lakes has been developed more fully in the reports of other panels and need not be repeated here. We simply note that the problem has many dimensions that touch the fisheries, usually adversely. Industrial wastes and oxygen–depleting organisms fertilized by processed sewage have taken their toll. Unwise development of agricultural and forested areas has damaged the nearshore environment through soil erosion. Herbicides and pesticides have reached dangerous levels in many parts of the Great Lakes. The constant pressure for industrial and commercial locations on the lake front has inflicted irreparable damage on the shoreline environment in many areas, with consequent reductions in fish productivity.

c. The Future Outlook It would be fatuous to argue that all of these adverse effects on the commercial and sport fishing potential of the Great Lakes could be reversed through implementation of a single set of recommendations, however wise. The land-water interface of the Great Lakes will continue to become more congested, and the impact of the tremendous population and industrial concentration in the North Central states will inevitably involve some costs in terms of environmental quality in all the Great Lakes. Nevertheless, there is evidence of sufficient public concern and of well conceived action programs to warrant limited optimism for the future. Cooperative efforts by the Canadian and U.S. governments, the States, and the Province of Ontario have brought the sea lamprey under control in Lake Superior, and the situation is sufficiently well in hand in Lake Michigan to make it feasible to undertake major rebuilding programs for valuable predator species. Thus far, lake trout appear to be well on the way toward reestablishment; steelhead are doing well in some areas; and experimental plants of coho salmon in Lake Michigan offer exciting prospects for a major new sport fishery and some commercial harvest.

Though much work remains to be done, Federal and State fishery researchers have made progress in defining the management problems that must be resolved before something approaching the most desirable balance of species and harvesting can be achieved. This is not simply a matter of "restoring" the Great Lakes fisheries; as indicated above, biological relations in the lakes have been so unstable in the past as to suggest the need for conscious selection of species and methods of harvest, with management and research programs geared to the technical requirements established by these choices. Nor could we expect the choices, once made, to remain unchanged for all time. The Great Lakes still offer opportunities (or perhaps need is a better term) for experimentation in producing outputs of greater benefit to mankind.

It is ironic that one of the major problems facing the marine fisheries is of far smaller dimensions in the Great Lakes because of the economic disasters of the past two decades. The commercial fishery, never particularly noted for technological progressiveness, was so battered by these developments that it has dwindled down to a very few men and vessels. Consequently, it will be possible to reestablish commercial fishing with due recognition of the need for balancing commercial and sports effort and with controls that limit the number of operating units. Given this approach to management of the commercial fisheries, it should be possible to permit the use of more efficient gear than the traditional gill net, pound net, and trap net, and thus to realize significantly lower operating costs than prevailed in the past. It must be recognized, however, that total potential from the Great Lakes is not large, in tonnage or value, and in terms of priorities the region offers less promising prospects than many marine fisheries.

Finally, the Great Lakes fisheries can only benefit from an aroused public demand for a national effort to control existing sources of pollution and to look beyond the present to future waste disposal programs that will permit eventual rehabilitation of most Great Lakes waters.

The need for a regional fishery management effort is just as clear in the Great Lakes as in the marine fisheries. Eight States, the Province of Ontario, and the Federal Governments of Canada and the United States are involved. A considerable amount of progress has been made in developing a unified approach, including the vitally important step of standardizing statistical procedures. Nevertheless, the need for full regionalization of the Great Lakes fisheries program is evident. There are a number of major policy problems that must be resolved as the rebuilding process gains momentum: for example, the allocation of fish between sport and commercial usage; techniques for controlling commercial fishing effort; the proper mix of species to be encouraged; and the presentation of a strong fishery case for effective water quality management. The recommendations for reorganization to insure action in the National interest for marine fisheries are equally applicable to those of the Great Lakes.

V. SPORT FISHING

A. Relation to Overall Fishery Development

Recreational fishing has become a major industry in the United States and a large part of the total sport fishing activity involves marine or estuarine species. As one of a variety of recreational usages of the marine environment, sport fishing is an important element in the Commission's proposals for an expanded research and management effort in that area. In this section we are concerned only with its impact on living resources and on the present and future areas of conflict with commercial users of fish.

It may clarify the following discussion to point out that the "output" of a sport fishery is not fish but fishing. The satisfaction is derived from the activity, and the proper unit of measurement of output is not pounds or numbers of fish but numbers of fishing days. Obviously, the number of fishing days and the intensity of the pleasure derived from them are not independent of the number of fish taken or of the eating qualities of the catch. The relationship, however, is indirect and sometimes surprisingly loose. For example, there is tremendous interest in sport fishing for tarpon and bonefish, neither of which is normally regarded as edible, and there is an intensive sport fishery for chinook and silver salmon on the Pacific Coast even in areas adjacent to major cities in which the catch averages less than .1 fish per angler day.

In general, however, sport fishing interest tends to center on species that are also commercially valuable, and in all cases the number of angler days does respond positively to changes in angler success. On both grounds, there exists potential conflict between sport fishermen, commercial fishermen, and other users of estuarine and inshore water. The conflict may involve use of the same species, use of one species that serves as food for another desired type or competition for the same space with incompatible equipment.

The general dimensions of the saltwater and estuarine sport fisheries of the United States and of major regions are set forth in Table 19. Several points stand out in these figures. First, the sheer magnitude of sport fishing, in almost every coastal area of the United States, makes it a major user of inshore waters and adjacent land areas. Second, the average expenditures required to get to the fishing area, properly equipped, are large

Table 19
SUMMARY OF SALT WATER ANGLING IN THE UNITED STATES[1] FOR 1960 and 1965

	U.S. Totals		Atlantic Coast[2] Totals		Gulf Coast[3] Totals		Pacific Coast[4] Totals	
	1960	1965	1960	1965	1960	1965	1960	1965
Number of fishermen	6,198,000	8,236,000	3,383,000	4,178,000	1,437,000	2,084,000	1,378,000	1,974,000
Days spent fishing	79,398,000	95,246,000	[5]	55,950,000	[5]	22,390,000	[5]	16,906,000
Dollars spent	$617,572,000	$789,789,000	$346,373,000	$331,179,000	$144,857,000	$176,104,000	$126,342,000	$282,506,000
Total catch (pounds)	1,380,301,000	1,474,353,000	731,852,000	836,481,000	411,110,000	375,575,000	237,339,000	262,297,000
Top ranked species by weight			Flatfishes, bluefish, jacks, red drum, striped bass	Bluefish, king mackerel, striped bass, groupers, porgy	Sea trouts, groupers, spearfishes, red drum, jacks	Spotted sea trout, red drum, white sea trout, yellowtail snapper, tarpon	Bonito, yellowtail, barracuda, striped bass, cabezon, sculpins[6]	Bonito, rockfishes, smelts, pacific bass, striped bass[6]

Source: Bureau of Census Survey for Bureau of Sport Fisheries and Wildlife.

[1] Does not include Hawaii.

[2] Maine to Florida Keys.

[3] Florida Keys to Mexican border.

[4] Alaska to Point Conception.

[5] Data not available.

[6] These rankings reflect the heavy population concentration in Southern California. North of San Francisco, sport catches of marine and anadromous species are dominated by chinook and coho salmon and steelhead trout.

enough to make sport fishing a major U.S. industry. The magnitude of sport fishing becomes even greater if its strong influence in expanding boating activities in the marine environment is taken into account. Finally, the demographic changes which are bringing an even larger proportion of the American people to or close to coastal areas imply a rapid rate of growth in demand for this kind of recreational service. This conclusion is strengthened by the fact that sport fishing, like other outdoor recreational activities, is highly sensitive to increases in personal incomes and leisure time.

The point need not be labored. Sport fishing is big business; it is widely shared as an activity that touches the lives of a very large number of American families and it is tinged with an emotion that gives it a political and social strength beyond the number of participants. Clearly it must be considered a major factor in planning future use of the inshore and estuarine environment. It will not be easy to provide for the growing demands of saltwater anglers. Many of the most desirable sport fish are already under heavy pressure from both types of fishing and from progressive deterioration in habitat. It is becoming more difficult and expensive to provide convenient access to preferred areas for fishermen and boats. Fishermen are increasingly in competition with other recreational users of coastal and estuarine waters and problems of overcrowding are becoming all too common. Not only fish but space and the ability to reach the fishing area quickly and conveniently are required to meet the demand for sport fishing in both quantitative and qualitative senses.

B. Areas of Expansion and Decline

Expansion of marine sport fishing can be aided by removal of catch limits where such limits are not biologically justified. For example, no justification can be demonstrated at present for restrictions on the catch of albacore, yellowtail, or rockfish. The only justification for these regulations on sport catch of marine fish is based on elimination of "waste of fish" and the setting of catch goals (limits) for the marine angler. Neither argument is tenable from the biological management point of view. There may well be cases where catch limits are required, however, to assure an optimal distribution of catch between sport and commercial usage, but this is a socioeconomic choice.

Technologically, the marine game fish angler has progressed little in the type of gear and method of fishing in the past two decades. The introduction of the spinning reel, fiberglas rod, and synthetic fishing line represents the most notable change, and this change has increased the chances of fishing success; however, the basic techniques of capturing the various species remain much the same. To some extent this may reflect the tendency of many anglers to regard improved gear or methods as "unsporting," and consequent pressure to outlaw them. Development of the ability to predict the location and concentrations of fish and to locate and position major concentrations in the general area known as the "fishing grounds" offers the greatest opportunity for technological expansion. Increase of angler success could result in a larger increase in angler participation, since participation is directly related to angler success.

Unfortunately, there are possibilities for declines in several marine and anadromous species of importance to the marine game fish angler unless vigorous action is taken. Salmon and striped bass resources will be increasingly in jeopardy due to loss of natural spawning grounds and insufficient water flows to keep spawning areas in production resulting from the development of large water storage facilities and diversions. This can be mitigated to a degree by management of water flow on the remaining spawning grounds and to a small degree by the development of artificial aids. However, the long-term outlook for the salmon in the western United States and in the southern drainage systems, such as the Sacramento River, is for a decline unless considerably increased efforts in artificial propagation are forthcoming.

Striped bass may also come under pressure as an important marine game species for the same reasons as salmon—reduction or elimination of freshwater spawning areas—though pressure on this species is much lighter on the Pacific Coast as compared to the Atlantic Coast.

Declines in catch per unit effort in most marine game species can be expected. Major game species affected will be albacore, white sea bass, yellowtail, barracuda, salmon species, bonito, mackerel, billfish, and rockfish. These declines will come about either if fishing by foreign nationals is unrestricted or if proper management of the species listed is not exercised.

Decline in species abundance can be expected for estuarine species in localized areas along the open coast unless a major national effort is undertaken to control pollution and poor use of both water and adjacent land areas. Those susceptible to increased pollution are the important species of striped bass, salmon, and seaperch in the estuarine areas and the coastal zone species of croakers, surfperch, flounders, kingfish, queenfish, and jacksmelt.

C. Management of Sport Fisheries

1. Requirements

Apart from the methods of harvesting, there is no real difference in the technical requirements for effective utilization of the living resources of the sea by recreational as opposed to commercial users. There are, however, important differences in political and economic aspects. In both cases, highly valuable species, particularly if accessible and readily taken, may be fished to the point where depletion is threatened and some curtailment of fishing mortality is required. The sport fishery shares, to a lesser degree, the corollary problem of developing new species and new areas not fully utilized at present. Either task requires extensive exploratory and biological investigation to establish the distribution, temporal variations in availability, and yield potential of the populations involved. Indeed, many of the same types of devices to regulate the catch are common to both sport and commercial fisheries: catch limits, prohibition of certain types of gear, and closed seasons and areas.

2. Jurisdictional Problems

The portion of the Bureau of Sport Fisheries and Wildlife budget devoted to marine fisheries is very small. To some extent, this reflects the greater concern of the agency with fresh water fisheries and wildlife management. It also reflects, however, the same dispersion of authority among the States and Federal Government that was noted in the discussion of commercial fisheries.

The jurisdictional problems involved are well illustrated by the situation with respect to salmon propagation and regulation on the Columbia River, the greatest single source of Pacific salmon in the continental United States. Salmon hatcheries are operated on the Columbia by both State agencies and the Bureau of Sport Fisheries and Wildlife, with financial assistance from the Bureau of Commercial Fisheries. All of the States concerned–Washington, Oregon, and Idaho–have regulatory authority over sport fishing, and in both Washington and Oregon a different State agency has jurisdiction over commercial fishing for the same fish. An interstate compact, the Pacific Marine Fisheries Commission, has some coordinating and investigative authority over troll-caught chinook and silver salmon from the Columbia. And since Columbia River salmon do not recognize State and National boundaries, they are taken in British Columbia waters by commercial and sport fishermen and are at least partially subject to international negotiations. Much effort has gone into coordination with considerable success but coordination is at best a poor substitute for unified analysis and decision-making.

The level and effectiveness of State programs designed to enhance, regulate, and protect marine and anadromous species of importance to sport fishermen vary widely. As in the case of commercial fisheries, there is serious friction in some instances (particularly where a given species is reserved for sportsmen in one State but can be taken by commercial fishermen in an adjoining State). Yet the States have found it very difficult, and in some cases impossible, to achieve uniform regulations covering species that migrate freely over State boundaries. Problems of this sort are made even more difficult by the fact that statistics covering marine sport fisheries are generally more spotty in coverage and less reliable than those covering commercial fisheries.

Within the individual States, the development and regulation of sport fishing is handled in a number of different ways. In many States, commercial and State fishing are under a single agency. In others, separate agencies are responsible for sport and commercial activities even though the same species may be involved. A commission form of agency is common, although in many States the director of the appropriate fishery or fish and game agency is appointed by the governor. Regardless of the form of organization, the number of participants in marine sport fishing, the natural tendency for saltwater and fresh water sport fishermen to band together in common interests, and the dollar magnitude of the supporting service industry involved make sport fishing a potent political force in the coastal and Great Lakes States.

3. Sources of Conflict

It is apparent that the roots of conflict between sport fishermen and other users of estuarine and inshore waters are numerous. It is equally clear that biological knowledge of the relevant populations involved is far from complete, even for some of the most important sport and commercial species. The result is a degree of confusion, ignorance, public misunderstanding, and emotional involvement that adds up to conflicts far more severe and extensive than would be expected if the facts were more widely known. For example, the violent objections of both commercial and sport fishing interests to seismic exploration by petroleum firms turned out to be largely unjustified after careful studies by fisheries scientists in cooperation with the industries involved. In some States, sportsmen have pressed for legislation prohibiting commercial use of species with little or no evidence of any adverse effect on recreational usage. In others, commercial fishery interests continue to use (and sometimes to overfish) species in areas and at times when they would make a greater economic contribution if reserved for sport fishing.

Part of the controversy can be traced directly to the absence of data sufficiently refined to distinguish the areas of real conflict from those that have no basis in fact. Even in the former, much can be done to minimize the problem. In many cases, adjustment of sport and commercial fishing seasons or areas to eliminate competition between incompatible types of equipment can resolve conflict to the net economic benefit of both groups.

D. A Program for Resolution

Although better communication and better scientific knowledge will go far to minimize unnecessary and distinctive controversy, the inescapable fact remains that some fish and shellfish, valuable to both sport and commercial harvesters, are fully exploited; any increased utilization by one group must be at the expense of the other.

It might be noted, parenthetically, that this situation is common throughout our entire economy; for example, desirable business locations and unusually gifted personnel are always in short supply, and would be useful to many different kinds of employers. In general, the market mechanism tends to sort out with reasonable efficiency the right factors of production for the right task. Each tends to be employed where it will make the greatest contribution to total production and therefore earn the highest return. Unfortunately, this mechanism simply will not function in the case of competition among sport and commercial fisheries, since the market provides no comparable valuation of recreational usage of the resource. What is required is careful analysis, on a case by case basis, of the economic and non-economic values involved in the alternative usages and a subsequent allocation based, however roughly, on the principles that the general public benefit should be maximized. This task sounds more formidable than it is in many cases. What is needed is not a precise determination of dollar values, but rather a "better than–worse than" comparison, and these are frequently available from rather straight-forward analytical procedures. Moreover, it is rarely true that use of a given resource must be entirely sport or entirely commercial.

Virtually all responsibility for management of sport fisheries is vested in the individual States at present. The role of the Federal Government is limited to research, technical assistance, and other service functions. Moreover, the Bureau of Sport Fisheries and Wildlife's resource management and investigation program includes management of wildlife refuges, wildlife research, and regulation of migratory birds and game. Less than 10 per cent of its budget for these purposes is directed toward fisheries, and an even smaller amount is spent on saltwater and anadromous species.

As a result, areas of overlap with the Bureau of Commercial Fisheries are not large, and duplication of effort has been largely avoided by effective coordination at both the top (through the office of the Commissioner for Fish and Wildlife) and at the operating level.

Nevertheless, the present division of the Fish and Wildlife Service into a Bureau of Commercial Fisheries and Bureau of Sport Fisheries and Wildlife is unsatisfactory in concept and operation in the marine environment. The two Bureaus are inevitably involved in activities relating to the same species, and it would be too much to expect that a perfectly smooth division of responsibilities could be achieved.

It would seem only logical that all marine and anadromous fish, regardless of sport or commercial utilization, should be handled by a single agency. Alternatively, all Fish and Wildlife Service fishery activities might be consolidated in the BCF. The Fish and Wildlife Service could then be of greater assistance to the various States in development and dissemination of accurate information relating to actual, potential, or imaginary conflicts between sport fishermen and other users of the same resources; it could lend its financial support to biological and technological studies aimed at reducing or eliminating conflicts of this sort. A unified agency would be more effective in this work than any type of coordinating device.

There is urgent need for applied research in the economic evaluation of recreational fishing. The general principles involved have been delineated in a number of publications (Crutchfield, 1966, provides a current discussion of these issues). No analytical framework, however satisfactory, can provide general answers for practical situations. These call for applied studies in each area where conflict exists or is anticipated.

The panel cannot emphasize too strongly the need for this type of program within the States themselves, since the Federal agency can do little more than facilitate. There are countless examples of discriminatory legislation, instituted by one group at the expense of the other, based on little or no scientific evidence that would stand careful analysis. Once such legislation is enacted, it becomes extremely difficult to remove it, since the vested interests that develop behind it are in a position to exert strong pressure against further change. There are far too many cases in which commercially valuable species are being wasted because of unwarranted angler opposition to commercial fishing. There is an equally large number of others in which commercial fishing makes serious inroads into populations that would be much more valuable as the base of a recreational industry. Both biological and economic assessment techniques have now reached standards that permit far better solutions to problems of conflict than these "meat-axe" techniques have brought.

Accurate statistics on total catch and fishing effort, place, and mode of capture are just as essential to effective resource management for sport fishing as for commercial. From such basic statistics it can be determined whether management is necessary, appropriate conservation measures can be designed, and their effectiveness can be evaluated. Such statistics must be compiled by small geographic areas and by small units of time.

Sport fish statistics are not nearly accurate enough to be useful for management purposes. Several methods to obtain adequate statistics have been discussed during the past several years which, if properly carried out, could provide the information desired.

1. Fish Licensing-Reporting System

–All marine anglers licensed

–Each required to report (on forms provided) weekly or monthly on fishing activities and success

–Estimates for non-reporters made from follow-up sample.

Such a system would be resented by many sport fishermen, particularly at first, but might be "sold" to them with proper public relations and education. Adequate staff for followup work would be necessary. A provision that non-reporters would not receive a license the following year would help enforce the reporting system.

2. Sampling System

–All marine anglers licensed

–A random sample of anglers' names drawn from licenses

–These anglers contacted by telephone weekly or monthly to determine fishing activities and success

–Total figures for whole fishery calculated from sample.

Either of these systems will call for a major effort by trained personnel, but could produce results accurate enough for management. The cost for salaries, supplies and travel to carry on such a comprehensive program would be substantial, even though the program be conducted according to a carefully designed sampling system, but without better data much of our management effort is literally blindfolded. As in the case of the commercial fishery a thorough overhaul and expansion of the Federal and State statistical programs is long overdue.

VI. OTHER USES OF THE SEA'S LIVING RESOURCES

A. Sea Plants

Although attention has been focused on the potential contribution of the sea to food supplies, and particularly to protein sources, the living resources of the sea can contribute in other significant ways to man's welfare.

Sea plants have been used for centuries as cattle fodder, soil conditioning materials, and even directly for human food. The Japanese consume about 20 varieties of seaweed, some directly and some in processed form. Seaweed has also served as a source of potash and iodine, both in Europe and the United States. A liquidized form currently is available to gardeners as a potent organic fertilizer.

Seaweed has pervaded American life in a more subtle way. Both the red and brown algae of the sea are sources of important hydrocolloids known as carageenans and algins. These colloids, chemically sugar polymers, are the basis for many convenience foods. Instant milk mixes depend on them, as do most dietary foods. They are widely used in baby food products, instant cake mixes, gelatin-type desserts, jams, jellies, and candies. They are important ingredients in most toothpastes, and contribute to the smooth texture of pharmaceuticals and cosmetics. Among the industrial uses of marine colloids are ink and automobile tire production. Algin production on the American West Coast depends on the availability of giant kelp. Carageenan production on the East Coast depends on a supply of red seaweeds. The U.S. industry has established seaweed harvesting and collecting points around the world to obtain a sufficient quantity of suitable algae.

Research conducted under the auspices of the University of California Institute of Marine Resources and the California Institute of Technology, in conjunction with California industry and government, have enabled scientists to restore some areas of the California kelp beds and to begin their expansion. Much remains to be done, however, in the artificial propagation of commercially important red algae. Some Sea Grant Projects are underway and development of seaweed aquaculture is an obvious future step.

Preliminary research has shown that seaweeds can be important sources for other human needs. One brown alga apparently contains significant amounts of fats which could be converted to vegetable oils. A green seaweed is so high in vegetable protein that it has the potential of producing tons per acre. A broad-spectrum germicide has been found in still another marine alga.

The panel believes that research into sea plant use has been neglected, in comparison with research into other resources, and recommends that the effort be increased substantially and that it include projects to determine the possibilities for aquaculture of useful varieties.

B. Pharmaceuticals

Activity in marine pharamacognosy and pharmacology is now at a level at which the groups concerned with the health sciences must carefully evaluate the sea as a source of new and useful medicinal raw materials. Using the definition of a bioactive substance as any substance, other than food, intended to affect the structure or function of the body of man or other animals, the interest is focused on pharmacologically active substances obtained from the plants and animals of the sea.

The medical history of people bordering the seas is replete with evidence that products with pharmaceutical applications are available from plants and animals inhabiting the sea. However, the present use of these products is small in comparison with those obtained from land organisms and their medically active constituents. With some exceptions, most of the marine drugs are used by native people in rather crude dosage forms, somewhat as the majority of crude botanical and zoological drugs and their extractives were in the United States 40 years ago. Other more refined principles, i.e., the biotoxins, appear to be too toxic for human use. Marine bioactive substances as a source of new commercial pharmaceutical products constitute an almost completely unexplored area of research. At the present time, there is not a single industrial organization or governmental agency that is making a continuous systematic exploration of new bioactive substances from marine creatures. (Bill S. 2661 was introduced in the 90th Congress by Senator Warren Magnuson to amend the Public Health Service Act, 42 U.S.C., Ch. 6A, Subch. III, for the establishment of a National Institute of Marine Medicine and Pharmacology in the National Institutes of Health. However, no action was taken on the bill.)

Contemporary experimental marine biology has indicated the potential of many other newer pharmacologically active substances being obtained from marine organisms. Many of these substances are usually categorized or considered as "toxins" or "poisons." However, their isolation, characterization, and ultimate attention can lead to useful medicines. In addition, these "new" molecular structures can serve as starting points for the synthesis of new classes of drugs. Already, many previously unknown molecules have been discovered, many of which have highly specific and unique activity. Study of poisonous marine organisms is required to understand marine ecology and the subsequent development of new protein food resources from the ocean. The subject of fish food poisoning is of concern, not only because of the need for protection against the illnesses caused by eating poison-laden fish foods, but also because of the probability that through scientific knowledge about the pharmacologic action of the toxic substances, new and useful drugs may be developed.

The majority of the bioactive substances from the sea now under study may be divided into two broad classes: the antibiotics, which are used to control and destroy the organisms that cause diseases, and the systemic drugs, which act directly on parts of the body. They alleviate pain, stimulate or relax, promote healing, vary the speed of certain biochemical reactions (such as blood clotting) influence the operation of certain organs, or act as antidotes to poisons. It is interesting that nearly all of these drugs are poisons themselves at suitable concentrations. Even the antibiotics are poisons, although they will presumably kill only pathogenic bacteria. There are more kinds of animals in the sea than on land, and a greater proportion of them use poisons as part of their equipment for survival. So far less than one percent of all the sea organisms known to contain biologically active materials have been studied.

Antibiotics from the marine world will become more important as the older drugs upon which medical practice has rested for the past 20 years become less effective against new generations of resistant germs. Casual use of powerful antibiotics for minor infections and in animal husbandry and agriculture has hastened this.

Recently, marine bacteria have been studied for their ability to form antibiotic substances. Several marine bacteria, isolated from tropical and polar seas, have been found to produce different kinds of potent antimicrobial substances. Some of these are especially active against certain kinds of yeast. Examples of antibiosis in various marine invertebrates are illustrated by work reported with gorgonian corals. Sponges also produce antibiotics, such as ectyonin and various other substances. Eight different terpenoid lactones have been demonstrated in the antibiotic gorgonians. Further study has indicated, also, that the "sybiotic" zooanthellae of alcyonarian corals contain cardinene and crassin acetate. Crassin acetate exerts a toxic action on parrot fish and sea urchins, but not in a species of snail which feeds on gorgonians.

A poison is merely an indicator of intense biological activity. Diluted, it is highly useful and often a very effective therapeutic agent. Probes among toxins for antitoxins have unearthed a host of fascinating pharmacological properties variously described as antiviral, antibiotic, antitumor, hemolytic, analgesic, psycho-pharmacological, cardioinhibitory, fungicidal, and growth inhibitory. Indications are that some marine toxins rank among the most toxic substances known. Chemicals isolated from certain toxic marine fishes are 200,000 times more powerful in blocking nervous activity than drugs currently used in laboratory research on nerve and brain activity. A substance extracted from the primitive hagfish has been used experimentally to slow down the heart during open-heart surgery, making it easier to operate. One of the most intriguing aspects of drugs from the sea is the presence of antitumor and antimicrobial agents in such common organisms as clams and oysters.

Attempts to find useful bioactive substances in the sea by searching folklore, studying biological activities of marine plants and animals or interviewing native witch doctors produce little and cost a lot. It costs even more to screen natural products at random by traditional methods. The major concern of drug companies is the marginal benefit or incremental return on investment. Drug companies have many more research opportunities than could possibly be undertaken due to a limitation in manpower and capital. There is a vast array of marine biochemical agents having potent biological activity. Many of these substances are candidates for potentially useful therapeutic agents, but these agents are not more intriguing than chemical and pharmacological researches with compounds obtained from land.

In order to effect a methodical evaluation of the sea as a source of new and useful bioactive substances, it is recommended that:

–A single, coordinated program that is National and international in scope be established.

–A systems management approach be utilized to eliminate duplication of effort and funding.

–The program provide for such elements as:

a. Inventory of presently known bioactive substances.
b. Examination of those factors which relate to the ecology of marine organisms and their pharmacology.
c. Determination of present pharmacological evaluation problems.
d. Institution of a national file for information storage and retrieval.
e. Development of inexpensive screening methods.
f. Provision of regional facilities for collecting, storing, and distributing bioactive material to universities, research institutes, and industry.

C. Marine Mammals

Marine mammal harvesting activities by the United States are confined almost entirely to the annual harvest of fur seals in the Pribilof Island area. The plight of the whale populations as a whole appears so hopeless that we anticipate no reason for United States participation in pelagic whaling operations in the foreseeable future, though there is some hope that the gray whale population may reach a level at which a considerable harvest could be taken.

VII. PRESENT LEVEL AND STRUCTURE OF FEDERAL GOVERNMENT ACTIVITY IN EXPLORATION, DEVELOPMENT, AND REGULATION OF LIVING MARINE RESOURCES

Many Federal Government agencies are involved in the acquisition of scientific information that is pertinent to or involves exploration, development, and regulation of the living resources of the sea. Some agencies or departments, such as ESSA and Navy, conduct extensive oceanic surveys and collect environmental information that can be synthesized and employed for making decisions concerning exploratory or actual fishing activities. Their inputs are also useful in the regulation of fisheries. These and other agencies provide financial support to individuals, universities, or other government agencies to carry out resource assessment activities. This is particularly true of the Atomic Energy Commission, the Navy, the National Science Foundation, and NASA.

The major Federal responsibility for conducting explorations to delineate latent aquatic resources and for their development and regulation in commercial usage is lodged in the United States Fish and Wildlife Service, Bureau of Commercial Fisheries. For this reason, discussions on the structure and level of government activity in the fields of government development and regulation will be confined primarily to this agency's activities.

A. Administrative Structure

The U.S. Fish and Wildlife Service involves two major bureaus, the Bureau of Commercial Fisheries (BCF) and the Bureau of Sport Fisheries and Wildlife (BSFW). The two bureaus are under the supervision of a commissioner and each has its own director.

The activities of BCF are organized for administrative purposes in six divisions. The activities of each division are further divided by work blocks which define branch activities. The field execution of the division and branch activities of BCF is undertaken by regional biological and technological laboratories or various service groups. The administration of the field work is divided by major geographic regions. In each region a director and assistant director coordinate, develop plans, and execute the field programs undertaken by the various divisions and branches within the Bureau.

In a strict administrative sense, all of the explorations conducted by BCF are lodged under the Division of Industrial Research, Branch of Exploratory Fishing. Development work, however, extends over several divisions, with major work undertaken by the Division of Resource Development. It is almost impossible to attribute responsibility for development work to any major division or branch because fisheries development work includes a single wide spectrum of activities. Functionally, almost all of the Bureau divisions, with the possible exception of administration, are at times involved in fisheries development activities, though the level is very small for most. Similarly, the responsibility for those activities which involve acquisition of information for the regulation and management of fisheries and the actual management of aquatic resources undertaken by the Bureau are vested in several divisions and numerous branches.

The administrative organization of the Bureau is therefore not the best framework in which to consider Federal activities involving exploration, development, and regulation of fisheries. It is more useful to examine these activities in terms of work blocks in a functional sense.

The major ocean activities in which the Bureau is involved, characterized by work objective, fall into four broad areas: resource assessment; extraction and use; environmental control and improvement; and management of aquatic living resources.

The resource assessment activities of the Bureau are generally undertaken by the Branch of Exploratory Fishing and various branches of the Division of Biological Research. The work includes the assessment of latent ocean resources and monitoring of those important commercial resources in or adjacent to our coasts under exploitation by United States and foreign fishermen.

Programs related to extraction and use of aquatic resources may be divided into those directed toward improving harvest and those geared to improved use (such as improving quality, reducing processing costs, and developing new products). The Branch of Exploratory Fishing is assigned the responsibility for increasing the efficiency of the extractive phase of fishing.

Environmental control and improvement relates to those activities designed to monitor the environment and gauge the influence of changing environment on aquatic resources. It also involves a variety of activities directed toward maintaining or improving the natural environment of fishes.

Management functions include not only the regulation of fisheries, but also acquisition of the scientific information on which to make management decisions and to deal with international conflicts. They also include Federal efforts to reduce current institutional barriers confronting effective development of a viable U.S. fishing industry.

B. Federal Exploration Efforts

As previously noted, the work of the BCF directed toward exploration is largely the responsibility of the Branch of Exploratory Fishing. This branch also has responsibility for gear development designed to improve harvesting systems.

Despite its key role in discharging the Bureau's responsibility, a relatively small part of the BCF budget has been devoted to exploration and gear development. The budget of the Branch of Exploratory Fishing through the first half of this decade ranged from $900,000 to $1.4 million. In the past several years it has been increased, and in 1967, $2.3 million was spent for this purpose. It should be noted, however, that the $2.3 million is divided between two basic objectives of the Branch of Exploratory Fishing: resource assessment and gear research. The greater share of this funding, perhaps as much as 70 per cent, has historically been devoted to exploration. Thus, the direct Bureau funding for exploration in the past five years is probably on the order of $600,000 to $1.5 million annually, and less than half that amount has been devoted to gear development. Again, however, because of the rather diverse branch functions, at least some of the activities undertaken by the Division of Biology, Branch of Marine Fisheries, have included exploratory efforts which have contributed to the knowledge of latent ocean resources. Actual budget figures for exploratory work are therefore somewhat higher than those specifically earmarked for that purpose, perhaps by as much as 50 per cent.

In addition to BCF's work, certain funds are allocated by the National Science Foundation for exploration of aquatic ocean resources, such as those provided for studies in the International

Indian Ocean Investigations and, more recently, for investigation of aquatic resources off the west coast of South America. Similarly, the Atomic Energy Commission has provided for this purpose funds to various academic institutions and to the Bureau, although they have been relatively small. For example, the Bureau of Commercial Fisheries receives about $57,000 annually from the Atomic Energy Commission for investigation of the deep-water demersal fauna in the region of the Columbia River on the west coast of the United States.

The total allocation of funds from all sources for exploration over the past decade has been surprisingly small in view of the Bureau's own rough forecasts of potential yields from aquatic resources and the need for better definition of the time/space distribution of these resources and their total potential if private investment in fisheries is to be expanded.

The Bureau of Commercial Fisheries currently has active exploratory fishing programs in five of its six regions. Relatively strong exploratory programs are in progress in the Gulf of Mexico, along the southeast coast of the United States, and in the Pacific Northwest off the coasts of Oregon, Washington, and British Columbia. A moderate exploratory program is conducted in the New England and Great Lakes States. The Alaska program is new and relatively small, despite the great latent potential in the area. BCF exploratory fishing programs in the waters off California and in the Hawaiian Island region are now very limited, although rather intensive work has been done previously off the coast of California and some exploratory fishing has been carried on around Hawaii.

The field work undertaken by the Branch of Exploratory Fishing is generally conducted by Bureau-owned vessels, and a large part of the budget allocated for exploration is utilized to maintain and operate these vessels. There are three such fishing vessels operating along the east coast and two small vessels along the Pacific coast of the United States.

The exploratory programs undertaken by the branch are generally organized to sample systematically major sectors of the aquatic community for example, demersal fish populations, pelagic fish populations, shellfish populations, etc. There is general agreement that the work completed to date has been of high quality. Relatively good indices have been provided, as a result of explorations, of the demersal fish potentials of the northeast Pacific and of the shellfish potential of the Gulf of Mexico. Work undertaken by the Woods Hole Biological Laboratory (Branch of Marine Fisheries) has also provided rather good forecasts of the demersal fish potential off the northeast coast of the United States. However, if one considers the present state of knowledge of the distribution, abundance, and yield potential of the fish and shellfish of United States coastal waters, the conclusion is inescapable that the level of the effort has been far too limited. We are simply in no position to provide the kind and quality of information on production potential that would be required to initiate a major increase in landings by U.S. flag vessels (assuming, for the moment, that the institutional barriers to such development were removed).

The magnitude of these gaps in knowledge is particularly frustrating since the response of industry to the findings of Bureau of Commercial Fisheries exploratory fishing activities has been generally positive and favorable. A prominent king crab producer in the Alaska area has stated that the exploratory fishing activities of the Bureau of Commercial Fisheries in the Bering Sea led to the development of the multi-million dollar king crab fishery that exists in Alaska today. Similarly, the pandalid shrimp surveys that were conducted in the waters of the northeast Pacific from southern Oregon to Kodiak Island were subsequently followed by a rapidly expanding shrimp industry. The Bureau survey work was completed in 1957, at which time less than three million pounds of pandalid shrimps were being harvested along the entire Pacific coast. In the last decade catches have expanded rapidly; they reached 50 million pounds in 1967 and may well exceed 70 million pounds in 1968. Obviously, all of the expansion of this fishery cannot be attributed to exploration by BCF, but certainly the speed with which it developed was in direct response to that work. As indicated below, the initial gross estimates developed from exploratory fishing programs must be followed by more refined resource assessment as data become available from expanded commercial fishing operations.

The currently rapidly growing scallop fishery in Alaska and the calico scallop fishery in Florida are other examples of industry's response to successful exploratory activities that could not be undertaken by any individual segment of the industry. The development of the Puget Sound and Pacific hake fishery and the growing industrial fisheries in the Gulf of Mexico also point to the stimulating effect of fishing surveys that are properly planned and executed.

In a paper presented to the Indo-Pacific Fisheries Council, Alverson and Pereyra (1968) reviewed the contribution of exploratory fishing activities to the ability to predict the development of major fisheries. Their findings show that in the northeast Pacific, exploratory fishing surveys conducted prior to the development of major fisheries had predicted all the dominant species which would subsequently sustain large scale commercial fisheries. In fact, the initial survey data, when reviewed subsequent to the development of large scale foreign fisheries, properly portrayed the probable magnitude of catches, geographic and bathymetric distribution of catches, and the species complex which would be exploited by major ecological zones. The survey work also provided the basis for a preliminary forecast of maximum sustainable yield figures. When the subsequently developed fisheries exceeded these forecast production potentials, catches in all cases subsequently declined and stabilized at lower levels.

Obviously, not all projects involving Federally supported exploratory activities have been followed by substantial increases in profitable production by the fishing industry. But given the examples cited above, backed by the simple logic of the fact that sensible investment decisions cannot possibly be made without reasonably accurate data on resource location and yield potential, it would appear that investments in exploration have been one of the profitable applied resource activities undertaken by the Bureau and should be expanded sharply.

C. Fisheries Development

In considering Federal efforts in fisheries development, efforts by the Bureau to improve harvest systems, to improve the quality of products, or to develop new products must be differentiated from direct financial aid to the fishing industry in the form of loans, grants, and vessel subsidies. The latter accounts for the lion's share of the budget made available for fisheries development work in recent years.

For example, in 1967 nearly $9 million of Federal funds were spent for the construction of fishing vessels, with funds dispersed in the way of vessel construction subsidies, loans for improving and upgrading fishing vessels, and fishing vessel mortgage insurance. By contrast, the Branch of Technology which is primarily responsible for improving the quality of fish landed, reducing fish processing costs, and developing new fish products, had a budget ranging between $1.5 and $2.7 million in the years 1963 through 1967. In addition to the funds allocated directly to the Bureau for these purposes, approximately $1.5 million was made available through Saltonstall-Kennedy funds for marketing and technological work. Hence the total budget for technological studies in 1967 was at a level of about $4 million. To this we must add certain funds that were expended for services, such as market news, statistics, economics, information on foreign fisheries trade, and fisheries education programs. All of the latter influence fisheries development work in one way or another. The dissemination of current information is a vital part of the operation of the markets for fish products and as a basis for investment decisions by the industry.

The service activities listed above received nearly $3 million of the Bureau budget in 1967. Of course, all of these funds cannot be considered applicable to the development aspects of fisheries. Much of the information garnered by the Branch of Statistics and various branches of the Division of Economics are also used in fisheries management and must be considered a partial contribution to the funds expended for that purpose.

Finally, only about $600,000 is now budgeted to the Branch of Exploratory Fishing for fishing gear development. With due allowance for the inability to identify all budget items by function, it would appear that approximately $6 million used directly by the Bureau enhances development of fisheries and another $9 million is paid out annually directly to the industry with this objective.

This summary view of the allocation of funds to various sectors of development work in the Bureau makes it clear that fishing gear development and the ocean engineering aspects of fisheries development have had extremely limited support. This is particularly surprising, since there is general agreement that search and harvesting costs are the prime obstacles to fuller use of latent resources in United States coastal waters and that the American fisheries, with the exception of tuna and shrimp operations, are technologically backward and generally inefficient. The Bureau can point to a few strikingly successful breakthroughs in gear development in recent years–midwater trawls for hake, improved shrimp nets, fast sinking seines, for example–but a budget of only $600,000 simply will not support more than a few projects. Perhaps more important, the limited budget and staff available in this type of work cannot investigate thoroughly bold and imaginative new concepts of fish harvesting.

D. Regulation

Bureau of Commercial Fisheries concern with regulation of living resources of the sea in a direct sense is minimal; the Bureau is not directly involved in managing or regulating the use of most of the resources exploited by domestic fishermen in waters overlying the Continental Shelf adjacent to the United States. Although authority apparently exists for Federal regulation of fisheries beyond the three mile limit, the Federal Government has generally not taken action to manage such resources except through international treaties and agreements. The State agencies have, in a sense, taken over by default responsibility for fishery regulation and management both inside and outside the three mile limit. When the United States is a party to international conventions, treaties, or agreements, however, the Federal Government has jurisdiction and the regulatory authority is lodged in the BCF. A detailed analysis of the problems involved in the exercise of State authority over fishing regulation and in international management programs is presented in a subsequent section. The panel merely notes here the administrative mechanisms of the Federal Government.

Responsibility for research on the status of fish stocks and implementation of management proposals for fisheries under jurisdiction of international conventions varies. In some instances each party to the convention may independently undertake research on the mutually managed resources. In such instances, the BCF would be assigned the task. Examples of this type of arrangement are the types of work undertaken for the International North Pacific Fisheries Commission and the International Commission for the Northwest Atlantic Fisheries.

In other instances, however, a convention may empower its commission to establish its own research arm. Examples are the International Pacific Halibut Commission and the International Tropical Tuna Commission. In such cases the Bureau is not involved directly in either research activities or in regulation of the fishery, but may play a role in the implementation of management recommendations stemming from the Commissions. The United States contribution to international commissions themselves are funded by the State Department.

In summary, the panel concludes that the Federal Government clearly has authority to develop and manage fisheries outside the three mile territorial seas, and, less clearly, to do so within that limit. It has chosen to ignore this responsibility, perhaps to forestall any State-Federal jurisdictional fight.

The States have undertaken the job, with varying degrees of enthusiasm and funding, but the general level of performance has been poor because States cannot mount the research required to maintain satisfactory understanding of stocks that move freely along the Continental Shelf and in oceanic waters far from the States. Fishermen and processors in various States have different views as to management policies, and the States have no authority to make agreements or conventions with foreign powers. For practical purposes, the position of the weakest State tends to set the pace for all where a fishery is shared. There can be no National policy toward fishery development and management as long as power rests in the hands of local governments acting on the basis of local interests.

Even when Federal authority is exercised, the BCF must rely on one or several States to provide such data and to counsel the government regarding conservation aspects of the resource in question, since the basic catch statistics and other research information required for intelligent management are often collected by State agencies. Such data are, moreover, of very uneven quality. There are, however, major exceptions in the cases (such as halibut and tuna) in which international commissions are staffed to provide such data.

The problem is further confused because design of research projects for management of resources in which the States are involved requires a community approach. Since each State may be expected to view any problem in terms of the interests of its own fishermen, the outcome is usually a research and management scheme reduced to the lowest possible denominator; constant squabbling for available funds; duplication of effort; inability to move in a decisive manner to deal with critical conservation problems whenever the benefits or burdens may accrue unequally; and total failure to mount a joint effort on long-range objectives.

Against this background it is pertinent to ask why BCF devotes a large portion of its budget to monitoring and documenting the effects of man's exploitation on a wide variety of commercial species taken in waters off the United States.

Much of this information takes the form of general life histories, investigations of the environment and its effect on the availability and distribution of resources, management theory, including the development of new population models. Nearly $20 million is annually spent for this purpose, even though the Bureau is not involved to a large degree in direct management of the resources. Moreover, implementation of findings, more often than not, requires that data and findings be routed to and through State agencies. On the other hand, we must recognize that the Federal conservation arm is the only national body capable of undertaking large scale research on ocean resources; without this information the development of rational use policies, for species which are strictly domestically exploited or for those in which the United States participates with other nations, would not be possible. It is not apparent, however, that many official, specifically formulated, recommendations have gone forth to the States.

The fact that implementation problems are severe is in no way a criticism of the quality of research undertaken by the Bureau as it relates to management of fisheries. The Bureau has built up a relatively strong research capacity in this area, and this fact, together with the greater sense of public urgency with conservation of over exploited species as compared to the more mundane task of developing new ones, has led to a strong tradition stressing this aspect of Federal concern with the fisheries. In addition, the Bureau's conservation programs have emphasized population dynamics and measurement of parameters, biological or physical, which may help to explain fluctuation in abundance that result from man's use of living marine resources. The equally important economic, social, and legal implications of regulation have received far less attention.

E. International Activities

In addition to the funds spent by the Bureau in the acquisition of information that may be utilized for the management of fisheries, it is directly involved in the management of the Pribilof Island stocks of fur seals, a small but eminently successful example of an international agreement that has stimulated rational use of a highly vulnerable resources.

In addition to funds that are normally expended by the BCF, several million dollars are provided through the State Department to the various fishery commissions with which the United States is associated. Considerable amounts are also made available through the State Department to international agencies concerned with fisheries exploration, development and management; the most important of these are the United Nations Development Program and the Food and Agriculture Organization of the United Nations. Other agencies which collect oceanographic and hydrographic information of value to fisheries investigators include, for example, UNESCO and WMO. Finally, a certain portion of funds available through the World Bank also find their way into fisheries exploration and development programs. The Asian Development Bank also contributes increasingly to financing fishery development.

F. Evaluation of the Federal Fisheries Effort

Since 1950 the Bureau's budget has accelerated sharply. The increase is particularly marked since 1960; in a seven-year period it more than doubled. During this same period (and extending back by two decades or more) no increase in United States fish landings has occurred. Indeed, if the stable total landings are disaggregated, it becomes clear that many fisheries have grown to a peak and then declined. Stability has been attained only by moving to new species or areas. Stated in different terms, landings have declined relative to what might have been expected if catches of most species had been stabilized, by proper management, at levels ranging from about 50 to 60 per cent of peak landings.

What has gone wrong? The years of work by the Bureau of Commercial Fisheries have not been sufficient to get the physical catch rate of the United States flag fleet in step with world development of ocean fisheries, nor to prevent a continuing and, in some areas, accelerating decline in the economic vitality of the American fishing industry. Even the rapid increases in funding and in the range of Bureau activities in the past decade do not seem to have produced any major change in these long term trends.

The causes of this disturbing record of performance cannot be pinned down to a few dramatic failures of commission or omission. Simple answers are rarely found for issues as complex as those besetting the U.S. fisheries. The Federal Government has never done justice to its functions in promoting rational use of the living resources of the sea because it fishery agency has never been given broad enough direction by the Congress to permit it to carry out a unified program to suit the needs of the country as a whole. The BCF program has evolved by a process of tacking on projects one by one, most of which have generally been thrust upon it to meet particular crises, often as the result of pressure by special groups. Appropriations are based principally on the support of these projects. Thus BCF is helpless to execute a dynamic program based on national needs; instead, it can only carry on with its agglomerate activities inherited from the past, and wait for further crises which its timely services would otherwise have averted.

The following diagnosis of Bureau operations, concepts, and organization is based on extensive interviews with a wide variety of people directly and indirectly concerned with its operation. The most important inputs have been provided by the Bureau itself. The panel does not hold it out as a definitive statement, but it does feel that it is a reasonably accurate explanation of the apparent failure to come to grips with basic problems afflicting the U.S. fishing industry, and that it points the way to a more positive and productive program. The panel states emphatically that the Bureau itself has been keenly aware of its own internal problems, and in recent years has formulated a series of recommendations for basic restatement of objectives and functions very much closer to those contemplated in this report. Many of the most critical changes are, however, still in the discussion phase, at either Bureau or Department level. The following analysis of the Federal fishery program is still appropriate as an explanation of the situation that prevails at present.

It is clear that the current program and organization of the Bureau of Commercial Fisheries do not reflect an integrated plan, geared to an unequivocal set of objectives. Like the agency, the budget has grown piecemeal over time, and much of the growth represents Bureau, industry, and congressional response to urgent problems of the moment. Many of these pressures generated projects and programs that long outlived the initial reason for their inception.

Because of this pattern of growth, together with the highly emotional and localized nature of the interest in fishery matters, the Bureau of Commercial Fisheries budget is marked by a high degree of inflexibility. Some of its programs are statutory in nature and cannot be altered by the Bureau itself. Others stem from projects of particular interest to individual legislators or strong industry groups, and can be eliminated or altered only with great difficulty. Still others are geared to unique abilities or special interests of scientific and technical personnel within the agency—in effect, good men get support for their areas of interest as long as they fall generally within the purview of the Bureau's responsibilities. It is unlikely that as much as 20 per cent of the BCF budget could be considered open to revision to meet new challenges and opportunities.

The resulting tendency of the BCF program to develop, by fits and starts, without reference to a considered set of priorities is accentuated by the absence of any clear cut statement of objectives. The congressional mandate to the Fish and Wildlife Service has never been completely clear, and even the legislation in 1956 that prescribes the official BCF mission is not specific enough to provide much guidance. The inevitable result has been a relatively comfortable and static approach to fishery problems, under which good people did good work on various projects in various areas without being overly concerned about the way in which particular operations meshed into National programs to achieve National objectives. The advent of Program Planning and Budgeting is beginning to exert a healthy pressure for change in this situation, but it is far from fully accepted, even within the Bureau, and its full benefits are yet to come.

A closely related aspect of Bureau operations that has inhibited its effectiveness in contributing to the vigor of American fishing industry has been the project orientation stemming from its organizational structure (which is disciplinary in nature) and the dominant position of administrators with narrow scientific or technical backgrounds. The emphasis has been on individual projects of merit rather than on programs oriented to the achievement of broader misssions that cut across both disciplinary and geographic boundaries. This orientation has been further strengthened by decentralization of authority within the Bureau under which a major part of the responsibility for initiation of programs rests with regional offices. There is a natural tendency to focus attention on problems of regional interest, and, even more narrowly, on those problems for which the region's own personnel are best equipped or in which they are most interested. Only by sheer accident would the resulting pattern of activities add up to effective *National* efforts designed to break bottlenecks in the development of under-utilized or latent resources or the more efficient management of those already under full exploitation, though they may produce good regional programs.

Another source of weakness is the geographic dispersal of BCF activities. To some extent this is, of course, inevitable in a Nation with as diverse marine resource units as those of the United States. However, the panel feels that the political pressure on BCF to spread its available funds and manpower among all regions of the Nation, with only secondary attention to the areas of greatest need and greatest potential, is a major deterrent to new initiative. One need only pose a question of the Congressional and industry reaction to severe curtailment of a Bureau program in region A in order to provide funds and personnel for a promising new opportunity in region B to appreciate the difficulty involved. Again, the key problem is the inability to conceive or adhere to a National policy while under heavy pressure to operate on the basis of local objectives.

As indicated briefly above, any assessment of the programs of BCF must be made in light of the tremendous influence of the tacit decision to allow the States to exercise jurisdiction over marine fishery matters within the three mile limit (and, for practical purposes, beyond that by exercising control over landings). The resulting welter of conflicting, parochial, and special interest legislation that encumbers both fishery development and fishery management activities is a primary reason for the discouraging performance of the American fishing industry in recent decades. Yet it is apparent that the Federal fishery agency, whatever its objectives and competence, is hopelessly handicapped in trying to undertake major programs that cut across State lines and—inevitably—offer rewards or impose burdens not equally distributed among the States involved.

Finally, the substantial rate of increase in BCF funding since 1950 started from an extremely low base. It can hardly be expected to show major effects as yet on landings or economic conditions in the fishery, given the long lead time between the initiation of resource evaluation and management programs and their impact on actual industry operations.

The reasons cited for failure of the Federal fishery effort to keep the U.S. flag fishery in step with world developments in the period following World War II are, to a considerable extent, beyond the control of BCF. They are due in part to pressures originating outside the Bureau, both economic and political, and in part to failure on the part of other branches of government, executive and legislative alike, to provide clear expression of the National interest in fisheries and specific objectives and guidelines to achieve it.

Other difficulties, however, appear to be of the Bureau's own doing to a greater extent. One of these is an apparent imbalance in the distribution of funds and personnel among the various BCF functions. In particular, the panel finds it discouraging that the state of knowledge of exploited and latent fish stocks on and adjacent to U.S. Continental Shelf waters is so deficient that BCF itself has called for a major increase in exploratory effort to provide private enterprise with sufficient detail to encourage expansion of American flag fishing activity. After many years of biological research and some exploratory effort, we are still unable to provide adequate and reliable information on the location, spatial and temporal distribution, and yield potential of more than a few major fish stocks found in U.S. coastal waters.

The panel finds it even more difficult to understand the extraordinarily low level of activity in ocean engineering and gear research and development. It has long been recognized that U.S. fishing operations were steadily losing ground to more sophisticated foreign competition with lower unit costs. While some of this could be attributed to lower labor costs in foreign fleets, the major gap between U.S. and foreign fishery development has developed in fishing operations that are highly capital-intensive, the very type of operation in which the United States should enjoy a comparative advantage, particularly in its own coastal waters.

There can be no doubt that U.S. fishing vessels lag behind their more aggressive international competition in vessel design, fishing equipment, fish detection equipment, propulsion systems, and the systematic analysis of deployment and harvesting methods. Yet BCF funding of programs to improve conventional fishing techniques and explore new methods has been so small that only a handful of projects could be undertaken.

Many of these would not have produced the excellent results they did except for persistent scrounging by project directors and contributions of equipment from industry. Moreover, the very small budget now available for investigation of detection, harvesting, and related techniques is divided among the various regional offices to a degree that keeps most of them below critical levels for efficient operation.

The panel prefers not to regard this problem as one of overemphasis on biological research or the scientific aspects of fishery investigation generally. A high degree of technical competence has been achieved in these areas by BCF, and it is vital to any overall program of fishery development and management that it be maintained. Far from being excessive, the funding provided for such work also needs expansion. Simply, there is a strong argument for a matching competence in exploration, technological development, and ocean engineering. BCF must be prepared and competent to provide the U.S. fishermen with the background information and the technical capacity to operate efficiently in exploiting the stocks available in his own coastal waters.

BCF has also been sadly deficient in its ability to deal with economic problems. Ours is a market-oriented economy, and the success of any Federal fishery program must be measured in large part by its contribution to the output, employment, and net earnings position in private enterprises engaged in fishing, marketing, and processing. Services rendered by the Bureau in monitoring and interpreting developments in these areas have been negligible until recently. Moreover, the Bureau's participation in formulating international fishery policies demands economic staff work of a high degree of professional competence.

Only in the past five years has BCF recognized this deficiency and made a determined effort to recruit and provide adequate organizational placement of professionally trained economists with experience in fishery matters. The panel regards the achievements of the Division of Economics over the past few years as clear evidence of the need to expand this type of work sharply. The Bureau's economists are now beginning to lay a solid groundwork of analytical and empirical background for the deployment of BCF resources and to establish a framework for current economic analysis within which day-to-day problems can be handled effectively.

The need for such work is pointed up by the inadequacies of the statistical data base on which many National fishery programs must be based. As might be expected, the deficiencies make it impossible at the present time to assess the economic health of any segment of the U.S. fishing industry or to forecast the economic results of alternative programs without detailed ad hoc efforts to develop the necessary factual background, case by case. Statistical information on the processing and marketing sectors of the economy, particularly with respect to prices, wages, and net earnings, is almost entirely lacking, except for a few major segments of the industry. Even in the more traditional types of data, there are substantial gaps. Thus, the coverage of landings, and—in particular—fishing effort, is still very spotty. To some extent, this situation reflects the dependence of BCF on State agencies for collection of primary data. Since the States have their own reasons for gathering statistical information and their own ideas as to the relative weight such activities should carry in their own budgets, the resulting data are of very uneven coverage and reliability.

Rectification of State data to make them comparable is a substantial task in itself, and the resulting regional and National totals are neither as timely nor as complete as the BCF mission demands.

The Bureau has been made aware of most of these deficiencies in recent years, largely through its own efforts, and it is in the process of revising substantially its own operating procedures, organization, and programming methods. Nevertheless, most of these efforts are of very recent origin, and the conclusion remains that inadequacies in the Federal fishery program, some traceable to external forces and some to inadequacies within the Bureau itself, have contributed substantially to the stagnancy of the American flag fisheries in recent decades.

VIII. THE ROLE OF THE STATES

Because of the importance and complexity of the legal relations of the States and the Federal Government with respect to fishery resources, a detailed analysis of such jurisdictional issues is presented in Appendix A to Section 1.

Traditionally, jurisdiction over fisheries within the territorial waters of the United States has been vested in the individual States. State programs are as diverse as the natural resources, people, and economic conditions upon which they are based. While they accomplish the tasks of research, management, regulation, and education, they do so with widely differing levels of effort and efficiency. Regardless of the proficiency of staff and administration, State fisheries agencies frequently remain thwarted by political and biological conditions beyond their control–as do their Federal counterparts.

A. Research

Most States support research facilities and activities as a part of their State fisheries agency's program; some, such as Virginia and Mississippi, prefer to assign this role to their higher education system. (John I. Thompson Co., 1968) Whatever the responsible agency, State marine fisheries research is concentrated within the estuarine zone and inshore oceanic waters, with only limited attempts and capabilities for work in the more offshore oceanic area. These limited attempts leave a significant gap in the understanding of migratory marine species and pelagic stocks–a gap which must be filled by the Federal Government.

Enactment of the Commercial Fisheries Research and Development Act (P.L. 88-309) on May 20, 1964, opened a new era in State fisheries research and in Federal-State relations in marine fisheries matters. The Act authorizes a five-year program which would provide $5 million annually for apportionment among the States to carry out projects on a cost-sharing basis: $400,000 for each of the first two years and $650,000 for each of the next three years to restore fisheries affected by a resource disaster, and $100,000 annually to establish new commercial fisheries. During its first four years, P.L. 88-309 has funded 240 individual projects at a cost of approximately $4 million in State and $12 million in Federal funds. Provisions of the Act have been implemented in 49 States, Puerto Rico, the Virgin Islands, Guam, and American Samoa. It has provided employment opportunities for about 150 technical and professional personnel new to the commercial fisheries field, and permitted the construction of six new State research vessels, seven new State research laboratories, and the renovation on an existing one. Significantly, the Act has generated a new level of understanding and cooperation between the Federal Government and the individual States. Unfortunately, P.L. 88-309 has never been completely funded. Only $4.1 million of the authorized $5 million annually has been provided for aid to the States; only $400,000 of the authorized $650,000 for resource disasters during Fiscal Years 1966-1968; and none for establishment of new commercial fisheries.

The Anadromous and Great Lakes Fisheries Act of 1965 (P.L. 89-304) authorizes cooperative projects with the States and other non-Federal interests for work directed toward the development and enhancement of anadromous fisheries. Federal funds up to 50 per cent may be used to finance project costs. The program is administered jointly by the Bureau of Sport Fisheries and Wildlife and the Bureau of Commercial Fisheries. $4.3 million was appropriated for non-Federal use during Fiscal Year 1968. Authorized projects include research on striped bass in Alabama, Maryland, Louisiana, Mississippi, and North Carolina, sturgeon in South Carolina, salmon in Alaska, California, Oregon, Washington, and shad in Connecticut, Delaware, Florida, Georgia, New Jersey, Oregon, and Pennsylvania. Appropriations have consistently fallen below the amount required to meet the authorization contained in the original Act.

Although the stated purposes of P.L. 88-309 and P.L. 89-304 are different, a number of similarities exist in the two programs. Almost all projects funded under P.L. 89-304 could have been funded under P.L. 88-309; the same general administrative procedures are followed in both programs; the same agencies and personnel are involved at both State and Federal level (except that BSFW administers half of the anadromous program, none of PL 88-309); and the same geographic area, i.e., the coastal zone and streams utilized by anadromous stocks, is dominant in both programs. It would therefore appear possible to combine both into one Federal aid program for marine and anadromous fisheries, with funding at the level expressed in the original bills.

B. Management and Regulation

Management of marine fisheries, in the sense of manipulating the resource to enhance or redirect its beneficial contributions to mankind, is still in a primitive condition. Oyster culture alone stands out as a noteworthy exception. States with access to sufficient shell resources (Maryland, Louisiana, Texas, and Florida) have demonstrated considerable success in expanding or rehabilitating their oyster resources both through management of public bottoms and encouragement of privately managed areas.

In other fisheries, management is carried out through regulatory procedures aimed at concentrating harvest during the period of maximum economic return or in rationing out the proceeds among the various participants. This includes the very difficult job of allocating shares to sport and commercial interests.

In many instances, States have been criticized for enacting or perpetuating restrictions in the name of "conservation," which serve primarily to lessen the efficiency of commercial fishing operations within their waters. Units of gear are limited, more efficient types of gear prohibited, catch and size restrictions arbitrarily assigned, and fishing activities restricted by time and place. Such restrictions are frequently requested, or even demanded, by the very group whose activities they restrict or by some competing group which happens to have the political strength at that particular time.

The solution becomes not a matter of insisting that the States take actions against the will of their majorities, or that Federal jurisdiction be invoked in all cases, but that the Nation adopt, as a matter of policy, that all fisheries are to be managed with the objective of maximizing their benefit to society, that regulatory action be based upon sound biological and economic data, that the individual States be encouraged to adopt a similar objective as a basis for their programs, and that every effort be made to inform the people concerned in each fishery of the effects of unsound regulatory measures based on other premises.

C. Education

It is readily apparent that few of the commercial fishermen and others participating in the use of marine fisheries resources know and utilize knowledge generated through efforts of Federal and State Governments, academic organizations, or industrial research and development. Most States have some sort of extension program, ranging from distribution of a newsletter to television productions and extension agents working in the field. Nevertheless, information is not getting around. Commercial fishermen do not use efficient detection and capture equipment such as scanning sonar, monofilament gill nets, Scottish seines, and stern trawlers whose superior performance has been well demonstrated, even in the absence of prohibitive legislation. Sport fishermen continue to engage in endless tirades against segments of the commercial fishing industry, such as the menhaden, thread herring, and anchovy fisheries, whose actual effects upon their interests are negligible in some cases and unknown in many others. Restrictive legislation continues to be promoted by groups of conservation-minded citizens who understand neither the biological nor economic implications of their actions. Thus the new National fisheries program should contain a concerted effort, in cooperation with the States, to bring the results of research and development to the actual users of fisheries resources, through a broad extension program involving all forms of educational media including personal contact.

D. Political and Biological Constraints

Regardless of the state of knowledge, the proficiency of State administrators and legislators, and the declared intent of State regulatory actions, individual State programs are frequently prevented from attaining their goals by political and biological constraints.

Local special interest groups may possess sufficient political power to prevent enactment of measures beneficial to the general public, or to gain legislation prejudicial to such interests. Even in the absence of such influences, States are often reticent to impose justified restrictive conditions upon their citizens when the benefit of such measures may be realized outside their boundaries.

We have not found a single instance in the history of the Atlantic States, Gulf States, and Pacific Marine Fisheries Commissions where two or more States have initiated and implemented coordinated measures for the efficient management of migratory marine species. There is an equally glaring absence of any concerted effort to expand the harvesting of underutilized resources.

Although the three marine fisheries compacts provide advice and recommendations to the member States and to the Federal Government, they were not intended to regulate fisheries in their respective regions. Regulation was left to the individual States, although two compacts were amended to permit regulation by the Marine Fisheries Commissions, if member States so chose.

E. The Need for New Organizational Arrangements

The present roles played by the Federal Government and the Marine Fisheries Commissions are inadequate to meet the needs of the U.S. fishing industries.

New organizational arrangements are required if fisheries management is to be attacked on species or regional bases as part of comprehensive resource development programs. The panel has reviewed several proposed organizational arrangements for the U.S. commercial and sport fisheries and has concluded that the role of the Federal Government should be reoriented toward resource development and the concentration of manpower and financial resources on National fisheries missions. Studies of fishing management and regulatory concepts should be undertaken and new management techniques instituted calling for increased coordination among the States and a greater Federal role in determining National fisheries policies and priorities.

The panel recommends that the Federal authority over U.S. marine and anadromous fishery activities be combined in a single bureau of one agency. The agency should be authorized to establish National priorities and fishery policies for the development and utilization of migratory marine species for commercial and recreational purposes, in cooperation with other Federal agencies, States, and interstate agencies. It should encourage cooperative activities by States for regulation and conservation of such species, sponsor research on the impact of institutional barriers inhibiting the efficient development of our commercial fisheries, and should encourage enactment of improved State and Federal laws relating to the regulation and conservation of such fisheries.

The measures proposed should strengthen the U.S. fishing industry and improve the fisheries programs of the various States. Under certain circumstances, however, these measures may be inadequate to meet the development and management needs of certain fisheries. Under the conditions stated below, the panel recommends that the Federal Government be given authority by the Congress to assume regulatory jurisdiction of endangered fisheries.

Such action should be taken when:

–It can be demonstrated that a particular stock of marine or anadromous fish migrates between the waters of one State and those of another, or between territorial waters and the contiguous zone or high seas

–The stock enters into interstate or international commerce

–Sound biological evidence demonstrates that the stock has been significantly reduced or endangered by acts of man

–The State or States within whose waters these conditions exist have not taken effective remedial action.

IX. A PROGRAM FOR REHABILITATION AND EXPANSION

Previous sections describe lost opportunities difficult to match in American economic history. In the years since World War II, demand for fishery products on a worldwide basis has expanded steadily with respect to both quantity and variety. During the same period, U.S. consumers, though using approximately the same quantities of fish and shellfish for direct consumption per capita, are using very much larger quantities of fishery products in the form of meal and oil for use in livestock and poultry feeding operations and for other industrial purposes. This rapid growth in industrial use of fishery products, coupled with an increasing population, has produced a very substantial increase in market demand for all types of fishery products within the United States.

During the same period, the technological level of vessels and equipment used for marine fishing has undergone revolutionary changes. Progress in this respect has been very uneven, but some of the traditionally important fishing nations, such as Norway, Japan, the United Kingdom and Canada, together with important new participants, such as the U.S.S.R., West Germany and Peru, have increased greatly the range and sweep efficiency of virtually all types of fishing equipment. In addition to improvements in equipment, there has been a notable expansion in the effort to coordinate oceanographic research and data accumulation with the deployment of mobile fleets of fishing vessels. No nation has yet achieved all that can be expected in this direction, but many, particularly the Soviet Union, have made real progress in integrating oceanic parameters, the abundance of fish, the behavior of fish, and construction and use of the appropriate kinds of fishing gear. These developments are reflected in a growth rate in landings on worldwide basis in excess of six per cent per year since 1950.

During this period of burgeoning demand and improvements in the efficiency, range, and variety of fishing units, many segments of the American flag fishery have been virtually stagnant. Total landings have remained almost unchanged (four to five billion pounds) for the past three decades, and only the development of a substantial industrial fishery has prevented an actual decline in landings. To some extent, this reflects full or even excessive utilization of some of the more valuable species found in United States waters such as salmon, halibut, some types of shellfish, and menhaden.

The latest and most authoritative estimates of potential yields from the waters adjacent to U.S. coasts show that the harvest is no more than one-tenth of the potentially marketable fish and shellfish available in areas where U.S. flag fishermen should have a significant advantage, in terms of availability, over foreign operators. Even more striking is the estimate that foreign flag fishermen are now taking from waters of the continental shelf adjoining the United States as much fish as U.S. flag fishermen are taking. The fact that foreign fleets are exploiting lower valued species points up even more clearly the gap in competitive efficiency.

There are, fortunately, a few bright spots. U.S. processing and marketing firms have played a major role in developing sources of supply in other parts of the world, and, in a real sense, this may be regarded as part of the total U.S. fishery effort. U.S. tuna and shrimp fishermen, using equipment and techniques second to none, have maintained a vigorous competitive stance, even though U.S. processing and marketing firms have required substantially increased imports as well as domestic production of these items. On the whole, however, growth in demand for fishery products in the United States since 1950 has been met from foreign sources.

The total Government effort directed at enlargement of the base of knowledge necessary to exploit fisheries profitably, and at direct development and management of existing fisheries, appears to be inadequate. It is fragmented between Federal and State agencies; it is funded at levels that do not permit the responsible agencies to mount bold or imaginative new programs; and the funds available appear to have been distributed, in response to traditional emphasis on biological research and to political pressures, in a manner that does not provide proper balance.

Exploratory work designed to provide the types of information on location, distribution, and potential yield that would stimulate private investment has been undertaken for only a few species. This is evidenced by the fact that these key factors can be quantified with reasonable accuracy for no more than a handful of our major fishery resources. For many underutilized and latent stocks, the key to any major expansion of U.S. flag fishing effort, available information is so inadequate as to restrict severely any sensible investment planning by the private sector. Similarly, efforts to improve existing gear, to develop new versions of conventional equipment, and to take the lead in research aimed at entirely new detection and harvesting techniques are budgeted at low levels.

These deficiencies and gaps in Government programming are particularly striking, since the panel finds clear evidence of highly successful work of both types by the BCF and by some State agencies. Successful, though limited, exploratory work has created several new industries now supporting profitable fishing ventures; and, even on a budget that permits only a few programs per year to function, breakthroughs have occured in developing new versions of conventional fishing gear that have been of great advantage to individual groups of U.S. fishermen.

The conclusion seems warranted that failure of the Federal effort to produce any increase in U.S. flag landings in the past three decades is attributable to the very restricted level of effort and to some imbalance in its program rather than to any absence of need for positive facilitating action by government. In a larger sense, the alarming position of the U.S. fisheries reflects a host of institutional, economic and social barriers to efficient development and management, and the absence, at State, National, and international levels, of organizations capable of assuring rational use of living resources of the sea.

A. Objectives

What does "rehabilitation of the American fishing industry" mean? What should be the objectives of an altered and expanded program aimed at "rehabilitation?" Perhaps the most logical procedure is to start with an indication of objectives which the panel regards as inappropriate.

First, the fact that the United States has slipped from second to sixth place among the world's fishing powers means nothing in and of itself. There is no logical reason why the United States should aim at producing more fish than any other country (or at second, third, or fourth place) merely for the sake of being first, second, third or fourth. Most major fishery products are now international objects of commerce. Some can be produced more efficiently by other nations than by the United States, and it is in the interest of both the processing-marketing sector of the fishing industry and the U.S. consumer that artificial barriers to buying wherever price and quality are best be reduced to a minimum. Efforts to expand the physical volume of U.S. landings simply for prestige purposes are almost certain to divert effort and funds from the far more productive alternative of concentrating effort on those areas where expansion is possible on a profitable basis because American producers have potential competitive advantages.

The panel also stresses the fact that "expanding employment in the fisheries" is not a legitimate objective of any program of rehabilitation. Most efforts to increase employment in the American fishing industry, have had the effect, intended or unintended, of repressing incentive and opportunity for modernization of fishing vessels and methods. In the long run they have contributed as much as any single source to the alarming decline in the competitive position of the U.S. industry. One authority recently noted that the impact of anticipated increases in wages (pressure for which arises from U.S. industries in which labor is used with greater productivity) could raise the costs of U.S. fishing enterprises by as much as 80 per cent over the next 15 years unless the industry shifts to more efficient techniques (Norton, 1968).

Finally, the panel stresses the need to analyze efficiency requirements for U.S. fishing enterprises in the light of U.S. conditions. The fact that other nations employ very large vessels, capable of fishing anywhere in the world, fleets employing mother ships and factory vessels that produce finished products of many kinds at sea does not mean that the United States should follow suit. Many of these nations employ such techniques simply because they must carry on fishing activities at long distances from home ports. There is much truth in the generalization that nothing can be done at sea as cheaply as it can ashore. Therefore, it is not only possible but likely that a thoroughly modern, competitive U.S. flag fishing fleet would include relatively few large distant water vessels capable of staying at sea over extended periods, and even fewer factory type vessels. What is needed are fleets geared technically to the physical tasks and economically to U.S.

costs of labor and capital and U.S. market preferences.

The panel therefore endorses the following statement of National objectives drafted by the Bureau of Commercial Fisheries:

To increase the net contribution of aquatic living commercial resources to the Nation's economy; to increase efficiency, so that the economic status of those engaged in the fishing industry is improved; to provide for the growing and diversified demands of the American people for fish and shellfish products, whether in the form of edible foods or other products, from efficient and economical sources; to seek means of bringing more of the world's aquatic resources into economic, commercial, production for the benefit of all mankind; and to contribute to man's understanding and control of aquatic living resources and their environment.

B. Elements of a Positive Program

1. Exploration

Rehabilitation of the U.S. fisheries must start with a sharper definition of the target. Commercial fishing is, at best, a highly uncertain venture; the risks become impossibly high in the absence of reasonably accurate information on the location, spatial and temporal distribution, and long run sustained yield capability of the resource concerned. Such information is particularly essential in the case of low valued fish that must be taken in quantity and fairly continuously for profitable operation. The first objective of an expanded exploratory effort must be to establish the dimensions of the resources which U.S. fishermen can reasonably expect to harvest profitably, and to provide a basis for reasonable investment decisions as to the type and quantity of fishing gear that should be used to harvest the resource on a continuing basis.

There will be other substantial benefits. The ratio of actual fishing time to time away from port is a critical element in the profitability of any fishing enterprise. A program aimed at providing the type of information described above for major stocks in U.S. coastal waters could be expected to reduce non-productive search and running time by as much as 10 to 15 per cent.

Perhaps the greatest benefit to be realized from a thorough delineation of the potential yield of fish and shellfish from waters available to U.S. fishermen is the ability to manage the resources on a rational basis. Fisheries of the United States, and, indeed, of most of the world, have shown a depressing tendency toward overexpansion, followed by a subsequent decline in landings and a long period of overcapacity and depressed earnings for the fishery concerned. Both the economic waste and the need for long and costly rehabilitation programs can be prevented by adequate forecasts, even of a fairly rough nature, of the quantities that can be taken on a sustained basis. Modern evaluation techniques make possible such assessments in the course of the exploratory fishing required to "place" the resource.

Finally, the present degree of overcapacity in both fishing and processing facilities in some of our important fisheries makes it particularly important to shift pressure to under-utilized resources that can be harvested and processed with the same equipment. Thus, the increasingly precarious position of the menhaden industry makes it highly desirable to develop alternate sources of supply from such species as thread herring and anchovies. Similarly, the distinct possibility that overcapacity already exists in the Alaska king crab fishery makes it imperative to develop as rapidly as possible the capacity to utilize tanner crabs, shrimp, and scallops in the Gulf of Alaska in order to provide a more diversified base.

The speed with which the major and secondary resources of the U.S. continental shelves can be covered systematically depends, of course, on funding, personnel, and ship time available. On the assumption that some ordering of priorities will be necessary because of constraints in both funds and personnel, the following suggestions for major initiatives are offered.

Shrimp, tanner crab, and scallops in the Gulf of Alaska—all high valued species with immediate markets and well developed technology—are logical candidates. Surface and midwater species such as thread herring, anchovies, and sea herring along the Mid- and South Atlantic coasts and the Gulf of Mexico provide inputs for the booming fishmeal market to supplement menhaden landings. Exploratory work also is required to develop the full potential for groundfish and shellfish in the Gulf of Mexico and Mid- and South Atlantic Coastal area; pelagic species in the Mid-Pacific south of Hawaii and off the Pacific Coast states; mid-water and surface resources off the New England Coast; and the groundfish and midwater resources in the Bering Sea and the Gulf of Alaska. Some of these resources are already under exploitation by foreign fleets; others are virtually untouched by any commercial operation. It would appear most desirable to concentrate on those species and areas in which U.S. vessels might be expected to enjoy a strong competitive position if they use modern vessels, gear and techniques. Basic exploration of internationally shared species would best be carried out on a multinational basis, with results to be made available to all participants.

The basic justification for an expanded public program of this sort lies in the widespread diffusion of the benefits generated. No single fishing enterprise or group of fishing enterprises could afford to undertake the necessary work, not only because of the scale of operations required, but because it could not hope to capture more than a small proportion of the total economic advantages generated.

2. Reduction in Costs of Vessels and Equipment

The relatively high cost position of most U.S. fisheries—the tuna and shrimp fisheries being the only notable exceptions—has continued to frustrate all efforts to expand the total U.S. fishing effort. No single factor accounts for this situation; the problem of making the U.S. industry cost competitive, at least in its own coastal waters, requires simultaneous action on a number of fronts.

The simplest to define, but one of the most difficult to deal with, is the high initial cost of vessels and major items of fishing gear. Under existing law, U.S. fishermen are unable to register foreign-built fishing vessels; another law proscribes the landing of fish in U.S. ports directly from fishing grounds unless landed in U.S.-registered vessels. In combination these two laws effectively prevent our fishermen from taking advantage of lower foreign shipyard costs. Except for a few cases, like U.S. shrimp boats, most fisheries vessels of equal or superior technical characteristics can be bought at much lower prices from a number of foreign countries.

Moreover, since the discrepancy in costs increases with the size and complexity of the vessel, the restriction reduces severely any financial incentive to bring American fleets up to the technical levels required for efficient high seas operation in many areas. The panel does not believe that the United States should simply duplicate the very large distant water vessels employed by other major fishing nations; it cannot escape the conclusion, however, that efficient vessels, capable of fishing in all but the most difficult weather conditions and over wide ranges, should be larger than those now employed in many U.S. fisheries.

A less widely publicized element in the high cost of U.S. fishing activity is the complex of high import duties on many important items of fishing equipment. For example, nets and twine, both important cost items in commercial fishing operations, could be obtained abroad at much lower prices if it were not for very high duties. The same is true for some types of instrumentation, such as precise positioning and sonar scanning gear, and for basic and auxiliary power sources. While no one of these factors is critical, in combination they add up to a definite competitive disadvantage for U.S. flag vessels.

The effects of these restrictions extend out in still other directions. Because they lead to greater obsolesence of an aging fleet, they contribute (together with Jones Act requirements) to the high cost of insurance that plagues U.S. fishermen. Similarly, the effort to pare costs at every turn in order to remain competitive has led U.S. fishing enterprises to provide working conditions that simply will not attract and hold efficient young men in the labor force. While there are some exceptions, the general working conditions of the U.S. fishermen are worse than almost any other major category of labor except migrant farm workers. For example, a $100,000 shrimp trawler, recently built for a major U.S. fishing corporation to operate off the coast of Latin America, has no shower or toilet facilities for crew members. Less than one-third of all U.S. fishing vessels would meet the minimum standards for safety and health of crew members developed for consideration of the fishing nations by the International Labor Organization. It is hardly surprising that the fishing industry finds it difficult to recruit young men, particularly in areas adjacent to metropolitan areas where diversified employment opportunities are available.

The panel recommends that legislation be enacted to remove the present legal restrictions on the use of foreign-built vessels by U.S. fishermen in the U.S. domestic fisheries, together with careful reconsideration of duties on important items of fishing equipment. It does not feel that large scale vessel subsidies are, over the long run, an effective substitute for these actions, even if modified to eliminate the unsatisfactory aspects of the present subsidy program. The most glaring weaknesses arise from the non-discriminatory character of the program. A considerable part of the funds expended has gone to the tuna industry, which is profitable and needs no help, or to fisheries already suffering from excess capacity. In addition, administrative obstacles have discouraged many of the very types of fishermen the legislation was intended to help.

The Bureau of Commercial Fisheries has proposed changes that would go far to remedy these faults. These include:

–A fixed rate of subsidy, not to exceed 50 per cent of the U.S. cost.

–Prohibition of the use of subsidized vessels in overcapitalized fisheries unless obsolete capacity is scrapped.

–Authorization for the Secretary of the Interior to establish priorities to insure that funds are directed to the proper fisheries.

If the archaic restrictions discussed above cannot be removed, a streamlined subsidy of this type is a possible palliative. The panel does not, however, feel that it will accomplish any permanent structural improvement in the U.S. flag fisheries, since it can and probably will be matched, wholly or in part, by foreign competitors. It leads inevitably to the inequity of competition between subsidized and non-subsidized vessels. Perhaps most serious, a subsidy large enough to make any real impression would require funding equal to about 60 per cent of the present BCF budget. The panel feels that these funds can be spent to better advantage in other ways.

3. Removal of Legal and Institutional Barriers to Efficiency

Marine fisheries commonly fall in the category of "common property resources." Traditional U.S. insistence on free entry to these fisheries, and the resulting inability to control the number of participants, has led inevitably to excessive commitment of labor and capital as the fishery matures, coupled in some cases with actual declines in sustained physical yields. It is particularly important to devise management frameworks that will prevent the development of such excess capacity rather than to deal with the painful and slow readjustments required after it has built up.

Despite the urgency of the common property problem–an urgency that increases with the rapid rise in world fishing effort and the steady improvement in other nations in the range and sweep efficiency of fishing equipment–mechanisms for rational management of fisheries to prevent economic waste simply do not exist at present in the United States.

The division of authority between Federal and State authorities restricts action to political boundaries that have no relation to the distribution patterns of the fishery resources that must be managed. In addition, the fragmentation of authority among the States raises serious disparities between local and National interests. It is quite common in specific management cases to find that the initial burden must be borne largely by fishermen in one State, while a disproportionate amount of the benefits accrue to fishermen in other areas. In the absence of some type of interstate or Federal authority which can realize fully the benefits of conservation and compensate, as required, those who must make temporary sacrifices, a sound management program cannot be devised.

Partly for this reason and partly because of the fragmentation of the industry, the U.S. fisheries have been saddled with an increasing burden of restrictive legislation, much of which has nothing at all to do with conservation in either physical or economic terms. Rather, it reflects the successful exercise of pressure by one group of fishermen against another; by sports fishermen against commercial organizations and vice versa; or by other users of water and land areas against fishermen. The end result is a monumental stock of overlapping, conflicting, and frequently unsound control measures, all parading under the guise of conservation. The effect has been not only to reduce the efficiency of the regulated fishermen, but also to discourage or even eliminate the incentive to build vessels properly equipped to exploit under-utilized or latent resources. Many, if not most, of the fisheries of the United States are sufficiently seasonal in character as to require multipurpose vessels and gear for profitable operation. Thus. efficiency-reducing regulations affecting one or more types of operation may make it virtually impossible to develop combined operations that would make greater use of underexploited stocks.

The seriousness of the common property problem and of the mass of restrictive legislation that has developed under State jurisdiction cannot be overemphasized. As long as the situation prevails, it is difficult to justify private, State, or Federal expenditures on improvement in gear or vessel efficiency. If such improvements are actually incorporated in operating units, the effect will be only temporary; improved profits will attract new units into the fishery, and the end result will be a restoration of the original earnings position with more excess capacity. It is more likely that any really important improvement would be legislated out of existence even before it could be adopted. The effectiveness of the recommendations for a major expansion of gear development and technology within the BCF is therefore dependent upon progress in removing these institutional impediments to progress.

The panel's concern over the debilitating effect of unwise management practices by both State and Federal agencies should not obscure the fact that many management techniques and programs have been distinctly beneficial. Regulations forbidding the use of destructive fishing gear or techniques, selective time and area closures that concentrate harvesting at times when the fish are found to be most plentiful and concentrated, and selectivity regulations that limit the catch of immature fish before they have achieved worthwhile growth are examples of such measures.

The panel therefore recommends, as an essential first step in cutting through the maze of unnecessary legislative restrictions, a series of careful studies of the objectives, operation, and biological and economic effects of specific regulatory programs in specific areas. While there are many obvious candidates for discard, there are also a large number of soundly conceived management programs that should be preserved or expanded in any revised approach.

Concurrently with such studies, the initial steps should be taken to prepare for a framework of management for both domestic and international fisheries in which National objectives are clearly specified as a paramount guide to policy.

The panel emphasizes that the overall effect of such pressure on the individual States to set their houses in order with respect to fishery management concepts and practices is not to be construed as a burden; parallel reductions of this type of restrictive legislation will provide an impetus to fishery development in the United States as a whole that must benefit all of the marine states and those bordering on the Great Lakes.

4. Technological Development of U.S. Fisheries

As indicated in the discussion of the BCF and its program, the panel feels that opportunities for improvement of U.S. fisheries' operations through gear development and associated ocean engineering have not been adequately recognized. Accordingly, it recommends formulation of a much more substantial program with these elements: improvement of conventional gear and adaptation to U.S. fisheries of technical developments originating elsewhere; research and development in the design and testing of new harvesting concepts that will make use of a growing national capacity to bring latent resources into use; development of a fishery intelligence service (and equipping of U.S. vessels with necessary communication equipment) that will permit integration of oceanographic and meteorological parameters with the deployment of fishing vessels; and establishment of effective lines of communication with industry through some form of extension service that will translate experimental work into practical fisheries operations.

The improvement of conventional fishing gear and the adaptation to local conditions of new equipment developed in the countries offer surprisingly wide opportunities for cost reduction in U.S. fisheries. A number of representative examples can be drawn from the limited activities of BCF. The design and construction of a large midwater trawl, coupled to a simple but highly effective electronic sensing device, provided the first step for a potentially large new hake fishery. Development of a fast sinking purse seine that will take fast swimming fish such as skipjack promises to open new opportunities for high seas purse seining by tuna vessels. U.S. vessels have scarcely begun to test the potential of various types of conventional sonar gear that is already standard equipment aboard many foreign fishing vessels; the same is true of high accuracy positioning equipment.

Work on a selective shrimp trawl, that would reject most of the trash fish that make life difficult for the shrimp fishermen while protecting the quality of the desired catch, promises to open new opportunities for the economical production of pandalid shrimp. Development work designed to protect the quality of fish at sea–an absolute prerequisite for the degree of quality control now demanded by the U.S. consumer–calls for much greater effort than BCF has been able to provide to date.

The list could be extended almost indefinitely. The essential point is that cost reduction is rarely a matter of one or two dramatic breakthroughs; real progress is likely to come from the less spectacular but more effective technique of financing and supporting a lively, imaginative program of doing simple things.

The limited budgets available for development work in detection and harvesting techniques have ruled out any major effort to pioneer new fishing concepts in BCF programs. As a result, there has been practically no work in the United States to parallel that being undertaken by a number of other nations, particularly the Soviet Union. The technical capacity for such work exists, both within and outside BCF; what is lacking is the specific mission, and with it the necessary funding and personnel.

By way of illustration, a number of potentially promising avenues of research can be cited for each of the functional elements that make up the fishing process. For example, rapid and reliable detection is essential to any effective sea fishing procedure. A great majority of U.S. fishermen are still dependent on crude physical detection systems. Most are limited to visual techniques, which are, for the most part, operative only at or very close to the air-sea interface. Even with the assistance of spotting aircraft, a technique available only for fleet operations or in the harvesting of very high valued fish, range is limited. The vertical detection range can be increased with acoustical devices but sonar gear presently available to U.S. fishermen has a relatively short range, does not provide positive identification of the target, and is relatively ineffective for small boats in rough weather.

BCF has done very little to develop better means of fish detection, and most of that has been confined to research sonar models intended for the use of BCF rather than for commercial fishing. Without elaborating further, the Panel feels that the potential for acoustical and optical fish detection is capable of very great improvement and equally important, can be brought within a price range that would make them attractive for use on small and medium sized fishing vessels.

Both passive and active acoustical detection systems require further research, and passive optical systems (including aerial and spacecraft spotting; airborne TV systems, spectro-photographic techniques, and infrared systems) offer promise. Laser systems may also provide high resolution detection at short range.

While many of these techniques are outside the capability of the BCF at present, it is essential that close liaison be maintained with the Navy, industrial firms, and academic and non-profit research institutions concerned with the basic problems involved. With any of these more distant concepts of fish detection, the critical point with respect to lead time to commercial utilization is the ability to detect, early in the research phase, and follow up areas of promise. Obviously, if it is not done by the Federal fishery agency it will not be done at all.

Radical improvements in conventional fishing gear and the development of new harvesting concepts are true research problems; what is required is a systematic attack on the functional relations that link the physical principles on which the gear in question operates, the biological principles that govern the possibility of capture, and the range of fishing strategies available for the unit carrying the gear.

Again, this can be regarded as a legitimate function of a public agency, since the benefits accrue to the industry as a whole and cannot be captured by a single firm.

5. Fish Protein Concentrate

The potential importance of fish protein concentrate as one element in the attack on the worldwide problem of animal protein deficiencies need not be emphasized in this panel report. In his State of the Union message for 1967 the President directed the Agency for International Development and the Department of the Interior to:

–Perfect low cost commercial processes for the production of fish protein concentrate.

–Develop new protein rich products that will fit into a variety of local diets.

–Encourage private investment in fish protein concentrate production and marketing as well as better fishing methods.

–Use this new product in our Food for Freedom program to fortify the diets of children and nursing mothers.

There are, however, a number of serious misunderstandings about the nature of the program, and in addition, a number of discouraging obstacles to large scale production despite repeated assurances that full success is just around the corner.

The panel cannot emphasize too strongly that "fish protein concentrate" is actually a large family of products, some of which are already intensively used and purchased in large quantities, while others remain in the embryonic stage. The fishmeal that accounts for much of the spectacular growth in markets and production of fishery products since 1950 is, in fact, a form of fish protein concentrate. It has been used very successfully to supplement formulated foods for various types of animals, the end result being both food and non-food products for human utilization. In this form, fish protein concentrate has grown from a world production of about 500,000 tons in 1964 to more than 4 million tons in 1966.

Production of what is normally referred to as "fish protein concentrate" involves a series of additional steps designed to produce a tasteless product that can be used as a protein supplement in foods directly consumed by humans such as soups, breads, and beverages. This requires a substantially larger reduction in oil content and certain other types of undesired physical elements, together with more rigid standards of sanitation at every stage in the production process.

Even this is too simple a view of the product, however. The degree to which taste and odor are removed, the degree to which grittiness must be reduced, the keeping qualities of the product over time, and even the form in which it is to be consumed are all variables rather than fixed elements. Thus far, research and development efforts by both private industry and the Federal Government have concentrated on achieving a tasteless, odorless product that can be stored over long periods of time and transported cheaply. In so doing, both have emphasized (correctly, in the panel's opinion), development of a product that would meet any possible objections on grounds of esthetic considerations and with the widest possible range of uses as a dietary supplement. In the interests of simplicity, the research effort has also concentrated on processes using lean fish, such as hake, that are readily available and lend themselves most easily to the production of the desired kinds of concentrate.

It is obvious, however, that tastes vary throughout the world, and that it is not only possible but certain that many different kinds of protein concentrate derived from fish should be developed to meet these demands. It is also far from certain that the very high standards initially established as a research goal need necessarily be followed in the production of all kinds of fish protein concentrate for all purposes.

The processes now being explored most intensively by private industry and by the BCF have not been established unequivocally as the only ones to be investigated or even the best. Variations of the types of solvent methods now under investigation and biological processing techniques both offer real promise, not only in terms of cost reduction but also in terms of the range of fish that can be handled and the number of different end products with different characteristics that may be forthcoming.

In the United States, progress has proceeded along two general lines. First, a private firm has developed a process for producing fish protein concentrate for animal feeding which was subsequently altered to derive a product suitable for direct human consumption. During the same period, the BCF undertook a rather substantial research program to pull together information on studies that had been made or were being made in various parts of the world. The program was aimed at deciding on a few of the most promising processes and developing these through the experimental stage into pilot production. The purpose of the exercise was to develop processes and engineering designs sufficiently detailed to permit private enterprise to undertake commercial production with no more than the normal business risks associated with a new product.

Unfortunately, progress has been slowed by a series of disputes and misunderstandings. Cooperation between the commercial developer of FPC and the Bureau's staff was less than ideal; and both were hampered severely by the intransigent attitude of the Food and Drug Administration toward fish protein concentrates made from whole fish.

After a long series of meetings, agreements, and formal actions, during which the developers of FPC met one objection by FDA after another, approval was granted to both the private firm and the BCF for commercial production with their respective processes. But this approval was tied to a requirement that the product could be sold in the United States only in one pound packages for home consumption.

The panel does not propose to pass judgment on the basis for this decision; it can only point out the effect of it. We now allow agencies of the United States to use fish protein concentrate for direct human consumption in public health programs outside the United States while continuing, for all practical purposes, the prohibition on its use for these purposes within the United States. No one can say with certainty that there exists a substantial market for fish protein concentrate in the United States. There has been enough expression of interest by food manufacturers to warrant the conclusion that the market should be tested, in the traditional fashion, by allowing food producers to use it in any way they see fit, as long as the strict Food and Drug Administration requirements with respect to process and product are adhered to rigidly. There can be no doubt that the speed with which the necessary technology, marketing techniques and channels, and families of end products and processes will be developed by industry is materially reduced by this restriction on package size.

The most important use for fish protein concentrate will doubtless be as a dietary supplement in areas where proteins in general, and animal proteins in particular, are chronically below minimum nutrition requirements. Unfortunately, these are the very low income areas where sophisticated market development techniques and organization are scarce, and where demand for "medicine" is particularly difficult to develop. It is likely, therefore, that for some time to come, the product must perform its very promising role in alleviating protein malnutrition on an institutional basis, with primary financial support from recipient governments and the United States. This does not, however, rule out the need for careful studies of socioeconomic conditions in the needy countries that bear on dietary habits and marketing arrangements. It is vital to the success of any major use of FPC as a public health measure that the best use be made of existing institutions, both Government and private business.

Pressure to undertake this worthwhile international program has resulted in commitments that may be very difficult to meet. Neither the commercial firm nor the BCF have yet resolved all the technical problems that must be settled before commercial production can be undertaken at prices that would make FPC attractive relative to other protein additives. Both processes still require the development of some technique for efficient recovery of the solvent used; otherwise, the cost becomes prohibitive. It is likely that such a system is in sight. In addition, both of the methods approved thus far by the Food and Drug Administration involve denaturation of the protein to an extent that limits the functional properties of the resulting product. This means, in turn, that the flexibility with which fish protein concentrate can be blended with formulated foods is reduced substantially.

Neither of these limitations constitutes an insuperable barrier to the widespread use of fish protein concentrate. It does mean, however, that the starvation budget provided to the BCF program for FPC must be supplemented sufficiently to permit completion of the projected pilot plant, resolution of the solvent recovery problem, and effective transfer of the whole body of information to private firms for commercial production.

There is also urgent need for adequate funding of work required to adapt the process to fatty fish, since a majority of the very cheap and abundant species that will eventually form the backbone of a fish protein concentrate industry are of this type. Finally, research into other methods of production and other end products should be increased substantially in order to make the best possible adaptation to taste, preferences, and marketing problems in all areas where protein supplements like FPC can be utilized. The total amounts involved are not large; the humanitarian and economic returns appear far more than enough to justify them.

The panel does not regard the fish protein concentrate program as a major element in rehabilitation of the U.S. fishing industry, although it may stimulate some activity along these lines, utilizing hake, thread herring, anchovies, or other latent or under-utilized species. The greatest advantage of FPC is to locate the processing plant next to the cheapest sources of supply anywhere in the world, and to transport and store the finished product at low cost. It is therefore likely that U.S. firms (and others) which may enter the industry on a large scale will locate plants in areas where fish can be obtained for $10-12 per ton, and where adequate support facilities are available.

The panel also recognizes that research and development is going forward on other types of protein concentrates. Private industry efforts to produce an economical protein concentrate from crude petroleum have drawn wide attention. Oil seed concentrates and the use of synthetic amino acids to improve the quality of vegetable proteins are other promising prospects. On the basis of present cost estimates, however, fish protein concentrate appears to warrant continued effort, particularly in view of the substantial progress already made. Moreover, nutrition experts are unanimous in the view that *all* sources of protein for human use must be expanded as rapidly as possible in view of impending world scarcities.

The same reasoning suggests the need to separate clearly the nutritional objectives of our foreign aid program from those involved in the development of new fishing industries. There is no logical reason why a U.S. program designed to alleviate protein deficiencies should be limited to those countries that have abundant supplies of cheap fish, a fishing industry that can be developed to produce raw material in satisfactory quantities, and a protein deficiency problem. What is more likely is that some nations may benefit substantially from the development of the new industry while many others will benefit from the contribution the product makes to dietary programs. There is no necessity that both be associated in a given country.

The panel supports strongly the concept of a Government research and development program to broaden the base of the FPC potential with the understanding that actual production and most of the market development will be a matter for private enterprise to undertake. At the same time, the panel stresses the need for Government financial support, whether by the United States, recipient governments, or both, if mass distribution of FPC is to be achieved. It is also quite possible that FPC will find profitable commercial markets, most likely in developed countries with sophisticated programs for formulating blended foods. If so, it will strengthen the overall technology and marketing capability of the industry. But the human need for animal protein is so great that every effort should be made to assure a combined private and government market for FPC that will induce private enterprise to proceed as rapidly as possible in translating the Bureau of Commercial Fisheries research program into a family of economical processes and products.

6. Institutional Arrangements for Technological Research and Development

As indicated in the preceding section, the panel places great emphasis on the need for expanded efforts to improve conventional methods of fishing gear and to explore new concepts and strategies in the light of current developments in materials, platform capability, and instrumentation. It does not find satisfactory organizational arrangements for such work within the BCF as now constituted. While it is clearly essential that such work be carried on by the BCF, in view of its intimate relation to other Bureau missions, it is equally necessary to establish close working connections with specialists in industry, the universities, and State agencies. In addition, some means must be provided for a blending of specific technical competence in ocean engineering, resource assessment, search and detection, harvest dynamics, fish behavior, and fishing strategy.

All of these skills exist in some degree within the Bureau already, and Bureau personnel have frequently established, on a more or less formal basis, close contact with people of like interests outside the Federal establishment. What is needed, then, is not a massive new effort but a central operating unit within which the relevant expert knowledge will be brought to bear on detection, harvest system dynamics, behavior of fish to fishing gear and physical stimuli, and concepts of fishing strategy.

The major function of such a group would be to work with the private sector of the engineering and fishing communities to focus attention on practical research and development problems that would stimulate more effective extraction of fishery resources. In view of the wide range of potential interests of such a group, it is expected that the bulk of the actual studies would be contracted out to academic institutions, the engineering community, and industry. Such contracts would not be concerned with long term research, but rather with clearly identifiable problems of fairly immediate significance, with greatest emphasis on those that offer a promise of stimulating subsequent development by the private sector.

It is therefore recommended by the panel that one or more fishery technological development centers be established within the framework of the BCF to carry on such work. While it is obviously desirable in the long run to have at least three such centers—one each in the Atlantic, Gulf, and Pacific areas—even a single center, with proper physical facilities and located in close proximity to strong university, engineering, and industry support could serve the national interest very effectively.

7. Aquaculture

At the present time, aquaculture is practical only on a limited scale except in parts of the Far East, where it has become integrated with specialized agricultural operations, and in European oyster and mussel culture. The aggregate contribution of aquaculture to world output of fish and shellfish is very small, and most of it comes from fresh water operations.

On the other hand, aquaculture supports a substantial number of small, local industries providing high priced specialty items, particularly in areas adjacent to major metropolitan areas. Much of Japan's fish farming effort is centered on shellfish, fin fish, and various types of marine plants that are highly prized in the restaurant and gourmet trade. Similarly, European operations are geared largely to specialty fish products from fresh and brackish water for the restaurant trade.

It is likely that this type of operation may also prove to be an attractive area for investment for localized private industry in various parts of the United States, though fresh water operations, particularly in the lower Mississippi Valley, and farming of mollusks in estuaries, appear more promising than salt water culture at present.

Marine aquaculture does not appear to hold great promise as a technique for bulk production of cheap protein food. In the foreseeable future it is clear that expansion of low priced fishery products from the sea can provide greater returns per dollar of investment than can be realized from known aquacultural techniques in salt water. From a longer run point of view, the possibilities of controlled genetic techniques and other extensions of scientific cultivation of living organisms on land remain essentially unknown. Given the urgent need for expansion of protein food, the necessary scientific and technological groundwork should be laid for a thorough exploration of these prospects.

In summary, aquaculture fully merits an expanded program of scientific investigation, starting from some evident basic research needs and moving forward to applications on an increasingly wide front as knowledge and technique are developed. It would not appear to be a high priority program, with respect to other areas of marine fisheries or to other elements of the National effort in the marine environment, and the most attractive intermediate term possibilities lie in fresh and brackish water.

The panel endorses the more detailed program and recommendations dealing with the technology of aquaculture in the Report of the Marine Engineering and Technology Panel.

X. REGULATION OF FISHERIES: WHY AND HOW?

Preceding sections have stressed the fact that there are large stocks of under-utilized fish and shellfish in U.S. coastal waters that offer a challenge and an opportunity for expansion of landings by U.S. vessels and, quite possibly, an increased share of the U.S. market. It should not be surprising, however, to find, side by side with latent resources capable of significant increases in output, others that are already being exploited at or beyond levels that maximize their contribution to the U.S. economy. The same situation prevails in all resource-oriented industries. In forest products, for example, there are serious adjustment problems resulting from cutting in excess of annual growth rates in some areas, while other less accessible forest areas, remain lightly harvested or completely untouched. It is necessary to impose strict controls on the production of oil in some areas while pursuing vigorously new sources, both onshore and offshore.

A rational Federal fishery program must deal simultaneously with regulation of some species to prevent depletion or even destruction, while providing all possible incentives for expansion of catches where biological limits have not been reached. It is of crucial importance, however, that all fishery management agencies and programs be cognizant of this dual responsibility. All too frequently regulatory programs have had the effect of slowing down or preventing the kinds of technological development required to expand operations on species not fully utilized.

Brief reference was made in the preceding section to the division of responsibility between Federal and State governments with respect to management of fishery resources, including both regulation programs and enhancement and propagation programs. There is great difficulty imposed on any National concept of fishery management under the present division of authority among Federal and State agencies, and the need for the kind of reorganization discussed in Section VIII becomes apparent from the following discussion.

A. Biological Determinants of Physical Yields

The commercial fisheries of the world rest on the productive capacity of a series of closely interdependent organic populations. Like a forest, perhaps the most similar type of useful living resource, a fish population exists in an enormously complex environment. It is impossible, however, to observe directly the size and composition of a specific fish population, nor can environmental conditions be controlled sufficiently to isolate the impact of specific changes known to affect it. Properly conducted, exploratory fishing can provide useful preliminary estimates of standing stocks and yield potentials. More refined estimates of the production possibilities from a given fishery resource cannot really be made until a well developed commercial fishery is operating on it.

The key variables determining production possibilities from a fish population can be grouped under three headings: rate of entry into the "fishable" age (recruitment), growth rates of individual fish, and natural mortality (from disease, old age, and non-human predators). In the absence of human intervention, a marine population tends toward a maximum aggregate weight, or biomass, at which net increments to stock from recruitment and growth are exactly offset by decrements from natural mortality. Thus, at zero and at maximum population levels the instantaneous rate of change in the weight of the fishery population is zero. At intermediate levels, the aggregate weight of the stock, in the absence of other disturbances, will tend to rise toward its maximum value, and the instantaneous rate of change in weight will be positive. It must be recognized, of course, that these long run equilibrating tendencies may be obscured by changes in the complex environments of the sea.

Assuming for the moment that recruitment and growth rates are independent of population size, these relationships can be translated into a simple physical production function. As fishing effort on an undisturbed stock (expressed in terms of standard units) is increased from zero level, sustainable yield—that is, the catch equal to the instantaneous rate of change in biomass in the absence of fishing by man—increases at a decreasing rate, while the number and average size of fish will decline continuously. If the selectivity of the gear with respect to fish of different sizes is held constant, the sustainable yield will peak at some level of fishing effort. Further increases in fishing effort will produce an absolute decline in sustained physical yield. Assuming a recruitment rate independent of population, fishing by man will yield a larger net physical product as long as the marginal reduction in weight losses from natural mortality is greater than the marginal weight loss resulting from capture of individual fish before they achieve maximum weight. Not all fisheries will show such a peak, however; given constant recruitment, the age at entry into the fishery, the individual fish growth function, and mortality rates will determine whether or not the yield-effort relationship is of this type. If the gear can be adjusted to reject fish below a selected size, a "eumetric" yield-effort function without a peak can be realized.

The assumption that recruitment is independent of population obviously cannot be of completely general validity over the population levels relevant to any commercial fishery. For anadromous fish such as salmon, the relationship is critical. Nature is so profligate in her production of fertilized eggs, however, that the case in which the number of marine fish surviving to catchable size is independent of the total standing stock over relevant ranges is the rule rather than the exception. The other assumptions are less tenable. Growth rates are almost certain to be density-dependent, as are some types of natural mortality, and the production possibilities implicit in the foregoing analysis are not necessarily reversible. As the size of the desired stock is reduced through commercial fishing, permanent shifts in predator–prey relations and in relative numbers of competing food users may occur. Large and frequent shifts in parameters are inevitable in the ecological setting of the sea.

If sense is to be made out of the concept of optimum utilization of a fishery resource, at least a rough delineation of physical production possibilities is essential. Analysis of the potential of a marine fishery population has progressed to the point where yields can be estimated within satisfactory limits for many stocks given estimates of only a few parameters. The uncertainty about long and short run effort-catch relations colors every aspect of the high seas fisheries, and knowledge does not come without its costs. But reasonably accurate knowledge of yield-effort relations is essential to development or management of any fishery.

These are crucial first steps toward efficient use of living resources of the sea. But even when good biological assessments of the size, range, and yield from a given fish population are developed, man seems determined to use it badly. Why is overfishing so common in developed fisheries based on valuable species? Why is the economic return in such cases so low? Why does not the industry provide, in its own interest, restraint on current production in order to assure the largest possible continued flow of output in the future? Answers to these questions are vital to the long run welfare of the U.S. (and world) fisheries. The following analysis of a hypothetical overfishing case provides some of them.

B. Economic Factors in Fishery Regulation

Assume, first, that the long run relationship between effort and yield, given the types of gear employed, is firmly established by empirical research. What level of effort and yield will actually prevail in the absence of regulation? What level *should* prevail? And if control is required to reach an optimal position, what methods of regulation should be used? These questions cannot be answered on the basis of physical magnitudes alone. Fisheries are carried on as commercial ventures in the United States, and effort will expand or contract as profit opportunities widen or narrow. But the cost of fishing depends not only on physical inputs of labor and capital but also on the price which must be paid for their use; and the money returns from fishing depend on both physical yields and product prices.

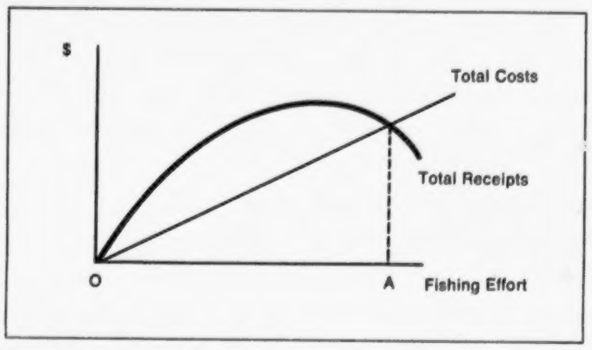


Figure 5. *The effort/yield curve in relation to total costs and total receipts.*

Assuming for the moment that fish prices, wages, and costs of vessels and gear are fixed, the effort-yield relation can be converted to one showing total money receipts and total fishing costs.

As long as there are no restrictions on entry, fishing effort will be pushed to the point where total receipts and total costs, including a minimum necessary profit to the vessel owner, are equal. At any lower level, profits would attract new boats; at any greater level, some would incur losses, and eventually would be forced out of the fishery. Obviously, any increase in prices or decrease in costs would result in an increase in effort and vice-versa. Full equilibrium in a fishery requires not only that the physical catch be stable but also that it sell for a price which just maintains the profitability of that amount of effort.

At the level of money costs and receipts assumed above, it is obvious that uncontrolled exploitation would lead to a smaller sustained physical and money yield than would be possible with less fishing effort and lower total costs. This apparent violation of business practice and common sense results from the fact that the resource is common property, owned by no one, and therefore regarded as a free good by all.

A rational private owner would use only those fishing units required to maximize the economic return on the valuable property right—rent, in a technical sense. But with unrestricted access to the fishery, any attempt to "conserve" by one fisherman or group simply increases the take of others. The net return potentially available from the fishery is wasted in excessive costs, through overcapacity in fishing gear and men, and through increased costs per unit as the population is depleted.

Moreover, this unhappy situation is couched only in terms of long run equilibrium, in which money returns are just sufficient to prevent further entry or exit at a rate of output consistent with stability in the size and composition of the fish stock. The development of a new fishery, however, is likely to be marked by a surge of new fishermen that carries capacity well beyond the levels appropriate for long run equilibrium. It is not only possible but normal for excess capacity to develop quickly and to persist over long periods of time, accentuated by the traditional immobility of labor in the fisheries and the related ability to maintain capital equipment at little or no real cost. It is no accident that the most valuable fish are often harvested by fishermen with the lowest incomes.

A fishery need not be depleted in this sense, of course, if cost-price relationships are less favorable than in the example given. In the extreme case, where no level of effort will produce enough income to cover costs, there is neither a fishery nor, in an economic sense, a resource. It is apparent that the level of effort, and the extent of overfishing, however defined, depend just as much on the economic factors affecting costs and prices as on the biological factors affecting physical yield.

A number of corollaries follow from this analysis. If, starting from an equilibrium point at or beyond maximum physical yield, market demand for the end product increases, the final result will be a higher price, higher real costs, and lower catch. Similarly, technological improvements in fishing, processing, or marketing which lower costs of production, will eventually reduce output and raise prices to consumers as the effects of more severe over-fishing become evident.

Two additional points deserve emphasis. These undesirable results stem not from ignorance but from rational efforts by businessmen to maximize profits. And they are not the result of monopoly; the more competitive the industry, in the absence of control over fishing effort, the more certain the resulting depletion and economic waste. The case for regulation of heavily exploited fisheries is very strong—and it is essentially an *economic* case. It should also be stressed that this concept of regulation requires specific types of biological and economic data. A fishery-by-fishery evaluation of the need for regulation should also include measures to provide these data.

Given the necessity of controlling the fishery for many valuable species, what should be the specific objectives? A review of the literature in the field of fisheries management leads to the conclusion that neither biologists nor economists have come to full agreement, separately, or among themselves, on this most vital starting point.

It would be unfair to say that the economic aspects of fishery management have been ignored, or that human welfare has not been regarded as a primary objective. Nevertheless, the fact remains that in salmon, halibut, tuna, and virtually all other practical regulatory programs the simple and apparently unambiguous objective of maximum sustained physical yield has been dominant. A regulatory scheme geared to this objective alone would provide better results than unrestricted fishing; but maximum physical yield, as a sole objective of fishery conservation, is not unambiguous, not simple, and not adequate.

It is simply impossible to make sense of fishing regulation except in economic terms. Why conserve fish at all? Unless the end products of the fishery are worth more in money than the cost of producing them there would be neither a fishery nor a conservation problem. Physical yield becomes important only if the value of the fish is assumed. The clarity of maximum physical yield as an objective becomes even more dubious if the fisheries are regarded as a whole, rather than singly. If part of the capital and labor now used in the salmon fishery, for example, were diverted to catching flounders and dogfish it is probable that we could expand physical output considerably. Obviously this would be nonsense, but only because the *value* of the catch, to consumers and producers, would be reduced.

Perhaps most serious, from the standpoint of the industry subject to conservation regulations, is the neglect of costs which can creep so easily into a management program geared only to physical yield. Any combination of measures which reduces fishing effort to the desired level is as good as any other if catch alone is the criterion. It is just as essential to take the desired catch in the most efficient possible way. Fishery stocks are not the only resources which can be wasted. Emphasis on this point in the recent proposed statement of BCF objectives is welcome, but has yet to be implemented.

If a fundamental premise of our enterprise economy (that market prices reflect consumer preferences reasonably well) is accepted, the objectives of fishery management are defined by the same standards by which the performance of other industries is judged. Following is a summary of these objectives.

1. Output and Resource Allocation

Other things equal, it would appear that the greater the production of fish the better. But it must be remembered that in period of reasonably full employment, more fish can be produced only at the cost of lower output of other products. The proper output would thus be that at which the additional cost of the last units produced is just offset by their additional value. Maximum physical yield would be the optimal output only if the labor and capital required to catch fish were completely costless. Otherwise, a slightly lower output would be preferable. With conservative management, which would normally hold catch slightly below the maximum obtainable, the difference between the actual and optimal yields would usually be small.

2. Efficiency

Regardless of the level of catch, optimal performance of the fishery would require that it be taken at the lowest possible cost. One of the goals of management must be to take the desired catch with the smallest number of units of the most efficient types.

3. Progressiveness

Management should provide both the means and the incentive for the development of improved fishing methods and their adoption.

4. Income Distribution

In an ideal fishery incomes would be shared among participants in accordance with their contribution to production, and would be at least equal to those which could be earned in other occupations.

This broader definition of the objectives of fishery regulation by no means down-grades the research role of the fishery biologist. The most difficult and important task remains, as always, quantification of the parameters determining the dynamic characteristics of exploited fish stocks. But there is a very real danger that the potential gains from management based on this research will be dissipated if the effects of alternative control measures on efficiency and progressiveness are ignored.

The first goal of fishery regulation—reduction of fishing mortality below levels which would prevail under free fishing—can be accomplished through one or more of four basic factors: the number of fishing units; the average fishing power per unit; the average time each unit is fished; and the geographic distribution of the units. Boiled down to the essence, this amounts to saying that catch can be held to the desired level by reducing effort or the efficiency of effort.

Once economic costs are introduced as a criterion of good management, all measures which reduce fishing mortality by cutting efficiency come under serious question. They may well be more beneficial in terms of economic yield than no regulation at all. But this usually begs the important question: can we achieve the same result by methods which do not impair efficiency? It can be argued that non-economic considerations may justify the use of inefficiency as a conservation technique. But those who do so are under obligation, rarely honored, to account for and justify the additional costs imposed on the economy and the industry.

An excellent example of failure to apply economic as well as biological criteria for regulation is provided by the Alaska salmon fishery. After decades of research and regulation, overfishing apparently persists, as evidenced by the steady decline in the Alaska salmon catch, which is now levelling out but is well below the peak five year period. Despite the efforts of able and dedicated scientists, our basic knowledge of the resource, one of the most complex in our fisheries, is not yet adequate to permit close management of all major populations. In the face of declining yields, virtually all measures of fishing capacity, such as the number of fishermen, units of gear, and tonnage of vessels, have increased sharply since 1946. In an effort to offset this, many regulations aimed specifically at reducing the efficiency of gear, preventing the application of new techniques, and increasing the time over which men and gear stand idle have been instituted. The degree of cooperation and voluntary compliance has not been satisfactory.

This is not intended as criticism of those charged with the hard, practical work of salmon research and regulation. The reasons for this line of development are partly political and partly sociological.

It is very important to emphasize that the root cause is a matter of business economics. It is abundantly clear that without regulation, prices and costs in the operation would lead to far higher short-run catch levels and, after a few cycles, to disaster. It should be equally clear that if the catch is limited to our best guess as to sustained maximum yield, money returns will be far more than enough to provide satisfactory incomes to the minimum number of fully utilized units required to take the catch. The surplus is economic rent–as in the case of agricultural land, when used efficiently in its best and highest use.

But the fishery resource is not owned, as land is, and if the regulatory authority cannot restrict entry, the surplus is simply used up in more under-utilized boats, gear, and men. That excess capacity, in turn, puts tremendous pressure on enforcement, since every vessel owner has a strong incentive to violate regulations. It leads to impossible concentrations of gear at the location of each successive run in a frantic effort to wring the largest possible output from the underemployed equipment. Until and unless it becomes possible to reduce the amount of gear to the minimum needed to take the permitted catch, economic waste, widespread violation of regulations, and a threat to the very existence of the industry will remain.

This problem is not unique to the fisheries. In greater or lesser degree it has plagued the petroleum industry, the forest products industry, and the use of public grazing land. In each of these cases, however, we have come, belatedly, to recognize that unrestricted access to a common property resource is fatal to wise conservation of the resource and to efficiency in the use of other productive factors. Only in the fisheries do we find resistance to principles which are fundamental to our free economy.

C. Policy Implications

The conclusions are obvious, though the panel recognizes that implementation in practice involves a host of difficult administrative problems. The principal means of restricting the fish catches to levels which will perpetuate and, in some areas, rebuild the industry must be to reduce the number of fishing units by restrictive licensing; to permit the development and use by these units of efficient gear; and to recover at least a portion of the "rent" which will accrue, as costs are reduced, through taxes, license fees, or auction of fishing rights.

This means that some public body should manage the resource to maximize its economic yield, leaving the actual operations to private enterprise. The economic rent would go to the fisherman, the vessel owner, and the State rather than being dissipated in higher costs. Precisely this principle is employed in the management of public forest and grazing land and, with some modification, in the leasing of publicly owned oil lands.

Obviously, this cannot be done soon without serious hardship to those who entered the industry in good faith. But if new entry could be prohibited, the normal process of attrition would enable us to reduce the glaring over-capacity without undue pressure on those now committed. Fishing boats and fishermen do grow old. Other types of back-up controls and catch restrictions would be required, of course, if for no other reason than our inability to forecast precisely in the complex marine environment.

Apart from the obvious saving in costs, and the resulting improvement in tax revenues and fishing incomes, a reduction in the number of fishing units would have a significant effect on the compliance problem. As long as regulations must cope with an industry literally "bulging at the seams," the difficulty of equitable enforcement of conservation measures is bound to be severe. If, however, the number of units is reduced sharply by methods which require an investment in the right to fish, the attitude toward illegal fishing may be quite different.

In addition, direct control over fishing inputs would enable the industry to move in an orderly fashion toward adoption of more efficient methods without fear of disastrous overfishing while the conversion was in process.

The importance of conservation methods which not only prevent physical depletion but reduce excessive economic costs was never greater than to the U.S. fishing industry today. The fisherman faces increasingly severe competition from imported fish and also from a host of other protein foods. Many segments of the industry are highly vulnerable to imports, and any regulatory program that operates through reduced efficiency is literally subsidizing a path into the U.S. market for a variety of competitive products.

To illustrate the practical application of a gear limitation program, two entirely different situations must be distinguished; first, how should the appropriate number of fishing units be determined and allocated for a newly developed fishery (or an established fishery for which a major new source of supply is suddenly opened)? Second, how can excessive numbers of boats and men be reduced in an established fishery that has already reached an unsatisfactory equilibrium with severe overfishing?

The first step in any gear reduction or entry limitation program must be to establish the legal base. Careful legal research has established unequivocally the right of the Federal Government to control entry to a fishery in cases where it presently has jurisdiction over fisheries subject to international agreement or carried on outside territorial waters.

The situation within individual States must be established case by case. In Alaska, for example, a specific provision in the State constitution guarantees unlimited right to access to the fisheries for all residents of the State. In Washington, by contrast, it has been argued that the State would have the right to institute a limited entry program of fishery management provided certain conditions are met. Access to the limited rights must be non-discriminatory; the legislature must consider appropriate and relevant factors formulating the program; and the program must be demonstrably aimed at improving the general welfare rather than that of the fishing industry alone.

It seems likely that most States could develop regulatory programs involving limitations of the number of fishing units, subject to these criteria, without further legislation; others may require specific legislation. The proposed reorganization of State and Federal responsibilities outlined in the earlier section would make possible the institution of a limited entry program in any interstate fishery.

Control over the number of fishing units in a newly developed fishery would present relatively few practical problems. Given a reasonably reliable estimate of long run yield effort relations in the critical ranges, the problem becomes one of determining the number of optimal vessels, efficiently equipped and fishing on a full-time basis, required to take the desired catch.

Since most yield effort relations will be subject to at least moderate variability from year to year, other backup control measures will be required. In general, an optimal fishery would operate with some excess capacity at all times. Occasional unexpectedly large harvesting opportunities would require short run extension of the number of license units, while curtailment of fishing time, quotas, or other restrictive devices would be necessary when available catches fall short of the long term average.

The actual techniques employed as backup measures to provide the necessary flexibility would depend on the characteristics of the species involved, the fishing gear employed, and the seasonal availability of the fish. Their effectiveness, in turn, would depend on the ability to forecast year to year availability with tolerable accuracy. The present state of fisheries science would permit such flexibility to be built in without major difficulty, provided the basic fishing capacity of the fleet in question was reasonably well adjusted to the average expected catch.

The speed with which a new fishery should be developed (the rate at which vessels should be admitted to the fishery until an optimal number can be determined accurately) depends in part on the biological characteristics of the fish involved. Those with a high growth rate and relatively short life history present fewer problems in that the population will rebound quickly once excessive effort is curtailed. Long lived, slow growing species, on the other hand, should be developed with considerably greater caution, since serious overfishing may require long recovery periods.

In any event, the development of a new fishery involves no serious problems of equity, since the limited licenses can be made freely available to all applicants on an auction or lot system, and no one need be displaced from his existing occupation unless he chooses to do so.

Much more serious problems arise in mature fisheries in which the threat of overfishing has been ignored or has been met by measures that reduce the efficiency of individual vessels without curtailing their number. In this situation, both sound economics and equity require that any gear reduction program be framed and timed to minimize individual hardship and compulsion. This implies that the rate of reduction in fishing units should be geared to the normal attrition of men and vessels, unless specifically accelerated by a program of purchasing and retiring fishing rights by a public agency. Given this ground rule, a practical and legally acceptable program of reducing fishing capacity to more sensible levels breaks down into five elements:

–How should the reduction actually be achieved?

–How rapidly should it proceed?

–On what basis should the restricted number of licenses be distributed to individual vessel owners?

–How should the reduction in gear be distributed among the various types of fishing equipment in use in the fishery?

–Should the economic gains from cost reduction be apportioned among fishermen, processors and distributors, and Government through market forces alone or should Government intervene?

A discussion of some of the issues raised by these questions can be found in Sinclair (1961); Crutchfield and Zellner (1961); Royce et al. (1963); and report of a working group to ICNAF (1967). The following elements of a proposed gear reduction program for salmon and halibut fisheries illustrate the kind of approach that might be followed, though other fisheries would require somewhat different treatment.

–The number of units of fishing gear of each type should be frozen temporarily at the level prevailing at the last fishing season. However, some reduction in the number of licenses available could be achieved immediately by weeding out vessels that have not fished at all during the past two or three years or, as in the recently announced British Columbia gear reduction program, by assigning them small catch quotas only.

–License fees should be raised to levels which bear a more realistic relationship to the value of the fishing privilege conferred. This would tend to eliminate much of the casual, quasi-commercial fishing, and should be adjusted to reflect differences in physical productivity of different kinds of gear. The license fee should be adjusted upward periodically to allow the public to share in the increasing value of the fisheries as excess capacity is reduced and fishing costs decreased.

–A revolving fund, serviced out of licensed revenues, would permit the State to purchase licenses and gear at a specified percentage of the insurable value of boat and equipment at the option of the owners. Boats purchased under this scheme would be retired or disposed of in such a way that they would not shift the pressure to other heavily exploited fisheries in the area. Fishermen relinquishing their licenses in this fashion and any other new entrants could participate only by purchasing an existing license.

–Licenses should be made renewable in order to permit the licensee to invest in vessel and gear with reasonable assurance of continued operation. It is equally important, to insure flexibility and to provide some pressure to keep the most efficient fishermen in the industry, that licenses be transferable. Prices at which licenses are sold would provide a continuing check on the economic condition of the fishery. In order to assure statistical control, and to exercise some control over flagrant violators of regulations, license transfers would be approved by the State fishery authority.

–In order to accommodate desirable technological improvements without subjecting the resource to undesirable pressure, the proportion of different types of gear in use could be made variable by allowing the introduction of more efficient gear with an appropriate retirement of existing licenses. Thus, it would be possible to shift to different kinds of gear whenever a cost advantage could be achieved without increasing the overall fishing capacity of the industry.

The elements outlined above obviously would not apply with equal facility to all domestic fisheries of the United States. In particular, fisheries such as the groundfish operations in New England, in which the individual vessel exploits a wide variety of different species, would present much more difficult problems. Nevertheless, the basic principles are applicable to a fairly large number of domestic fisheries, both intrastate and interstate, in which physical productivity of the stocks sets a measureable ceiling on catches.

The Commission recommends strongly that gear reduction programs of this general type be instituted in fisheries where the prospective problems are minimal in order to establish the working principles involved. Thereafter, it should be possible, with wider industry education and acceptance, to tackle the more difficult cases.

The same general objectives and principles of fishery management also apply to internationally shared fisheries, but the complications become far greater. Nations typically have diverse market preferences, costs, and social value systems, and no single "optimum fishery" can be defined that will be ideal for all. The problem of sharing net economic benefits among participants defies any simple economic or scientific analysis, but should be a matter for negotiation. And nations may, in some cases, be more interested in employment and foreign exchange considerations than in improving the economic efficiency of the operation.

Because of the extreme importance of establishing a rational international regime for harvesting living resources of the sea, and the interrelations between this and other aspects of international cooperation in marine activities, the subject is treated in greater detail in the Report of the International Panel. The reader is referred to Chapter 6 of that report; it is endorsed by this panel.

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Appendix A **Organizational Alternatives and Regulation of U.S. Commercial Fisheries**

I. DOMESTIC FISHERIES, REGULATION, AND THE COMMERCE CLAUSE

A. Ownership of Animals *Ferae Naturae*

The roots of western man's inharmony with his environment and his attitudes toward exploitation of natural resources were already evident in the Old Testament.[1] Whatever their origin there is deep-seated tradition in our law that every man, as an individual, has an equal right to pursue and take to his own use all such animals as are *ferae naturae*, i.e., of a wild nature, the property of no one, but liable to be seized by the first occupant. Traditionally, also, the sovereign has asserted ownership of migratory species, under a variety of theories. In Roman law, animals *ferae naturae* were considered to belong in common to all the citizens of the state. Speaking to English common law, Blackstone asserted that such animals were prerogative property vested in the King alone. The original 13 colonies succeeded to the rights of the Crown, from which has developed in American law theories regarding the ownership of wild game and fish. The rule of law which American courts have consistently recognized is that animals *ferae naturae* are owned by the States, not as proprietors, but in their sovereign capacity as the representatives and for the benefit of all their people in common. The property right is a *common ownership . . . to be exercised . . . as a trust for the benefit of the people, and not as a prerogative for the advantage of the government as distinct from the people, or for the benefit of private individuals as distinguished from the public good.*[2]

But the "ownership" is not unqualified. It is the law that whoever claims title to animal *ferae naturae* must first reduce them to possession.[3] Where statutes speak of title to game and fish as being in the State, they speak to the State's police power to regulate the taking and use of wild game and fish, do not affect a landowner's interest in land,[4] and have generally involved the relationship between a State and an individual, not between a State and the Federal Government.[5] The ownership theory is not without modification. "To put the claim of the State upon title is to lean upon a slender reed," said Mr. Justice Holmes, because wild animals are in the possession of no one and "possession is the beginning of ownership."[6] The ownership theory has been characterized as "a fiction expressive in legal shorthand of the importance to its people that a State have power to preserve and regulate the exploitation of an important resource."[7]

B. State Authority To Regulate Fish and Wildlife

Most of the Federal case law to date has dealt with the authority of the States to regulate the exploitation of wildlife by individuals, and has consistently held that as between the State and the individual the State can control and regulate the common property in game and fish within the jurisdiction of the State. In *McCready* v. *Virginia*, 94 U.S. 395 (1876), at issue was the power of the State of Virginia to prohibit citizens of other States from planting oysters within the internal or tide waters of that State, which power was upheld by the Court. *Manchester* v. *Massachusetts,* 139 U.S. 240 (1891), is cited as authority for the State of Massachusetts to control and regulate the catching of fish by individuals within the bays of that State. The authority of the State to control and regulate its own citizens in their exploitation of resources beyond the territorial sea, in the absence of Federal legislation, was confirmed in *Skiriotes* v. *Florida,* 313 U.S. 69 (1941), as was the authority of the State to control and regulate such exploitation by both citizens and noncitizens of the State while in the territorial sea boundaries of the State (*Toomer* v. *Witsell, supra*). For the effective enforcement of hunting and fishing restrictions, the State may forbid the possession within its borders of certain gear, such as nets, traps, and seines *(Miller* v. *McLaughlin,* 281 U.S. 261, 264 (1930)). The State may also forbid the transportation outside the State of game killed therein *(Geer* v. *Connecticut, supra),* and to make illegal the possession, during the closed season, of game imported from abroad *(Silz* v. *Hesterberg,* 211 U.S. 31 (1908)).

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[1] White, Lynn Jr., "The Historical Roots of Our Ecologic Crisis," 155 *Science* 1203, March 10, 1967; Baer, Richard A. Jr., "Land Misuse: A Theological Concern," *The Christian Century*, Oct. 12, 1966.

[2] *Geer* v. *Connecticut*, 161 U.S. 519, 529 (1896); *Martin* v. *Waddell*, 16 Pet. 367; *McCready* v. *Virginia*, 94 U.S. 391; *Smith* v. *Maryland*, 18 How. 71; *Manchester* v. *Massachusetts*, 139 U.S. 240; *Lawton* v. *Steele*, 152 U.S.133; *Ward* v. *Race Horse*, 163 U.S. 504; *Patsone* v. *Pennsylvania*, 232 U.S. 138; *United States* v. *McCullagh*, 221 Fed. 288; *United States* v. *Shauver*, 214 Fed. 154; *Silz* v. *Hesterberg*, 211 U.S. 31; *Kennedy* v. *Becker*, 241 U.S. 556. See also *Commonwealth* v. *Agway, Inc.*, 210 Pa. Superior Ct. 150 (1967).

[3] *Pierson* v. *Post*, 3 Caines 175 (N.Y., 1805). See also *Koop* v. *United States*, 296 F.2d 53 (C.C.A. 8, 1961).

[4] See *McKee* v. *Gratz*, 260 U.S. 127, 135 (1922).

[5] *Geer* v. *Connecticut, supra; Ward* v. *Race Horse, supra; Foster-Fountain Packing Co.* v. *Haydel*, 278 U.S. 1 (1928).

[6] *Missouri* v. *Holland*, 252 U.S. 416, 434 (1920).

[7] *Toomer* v. *Witsell*, 334 U.S. 385 (1948).

C. Treaties and Regulation

"No doubt it is true that as between a State and its inhabitants the State may regulate the killing and sale of [migratory] birds, but it does not follow that its authority is exclusive of paramount powers."[8] It is well settled in American law that as between a State and the Federal Government, laws passed pursuant to the valid exercise of the treaty-making power of the Federal Government[9] are the supreme law of the land. This was expressly confirmed in the landmark case of *Missouri* v. *Holland,* which held that the Migratory Bird Treaty[10] and the Migratory Bird Treaty Act[11] passed pursuant thereto were supreme law of the land, supervening State laws and creating rights superior to those of the States or their citizens.

D. Commerce Clause and Regulation

However, before the enactment of the Migratory Bird Treaty, there was doubt and uncertainty as to the power of the Congress to deal with the hunting and killing of game birds. In 1913, the Congress passed a law deeming migratory birds to be "within the custody and protection of the government of the United States," and asserted the authority of the Department of Agriculture to adopt suitable regulations to prescribe closed seasons and to prohibit the killing of migratory birds.[12] This Act was first contested in *United States* v. *Shauver,* 214 Fed. 154 (D.C.E.D. Ark., 1914). On initial hearing, counsel for the Government did not contend that power to enact the legislation was under the commerce clause, but under the power to make regulations respecting the property of the United States.[13] Citing numerous cases to the effect that "animals *ferae naturae* . . . are owned by the States, not as proprietors, but in their sovereign capacity as the representatives and for the benefit of all their people in common," the court stated that it was "unable to find any provision in the Constitution authorizing Congress, either expressly or by necessary implication, to protect or regulate the shooting of migratory wild game when in a state," and declared the Act unconstitutional. On rehearing, the court dismissed the case after counsel for the Government contended that the Act was authorized by the commerce clause.

To similar effect was *United States* v. *McCullagh,* 221 Fed. 288 (D.C. Kan., 1915), decided nine months after the *Shauver* case, and testing the same Act. Holding the Act unconstitutional, the court stated, 221 Fed. at 292:

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[8] Mr. Justice Holmes in *Missouri* v. *Holland,* 252 U.S. 416, 434 (1920).

[9] U.S. Const., art. I, §8, cl. 3.

[10] 39 Stat. 1702 (Dec. 8, 1916).

[11] Act of July 3, 1918, 40 Stat. 755, as amended, 49 Stat. 1556 (June 20, 1936), 16 U.S.C. 703-711.

[12] Act of March 4, 1913, 37 Stat. 828.

[13] Art. 4, §3, cl. 2, "The Congress shall have power to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States . . . "

> *[discussing* Geer v. Connecticut*] . . . it is there held the power of the state over game within its territorial limits is not terminated by the act of the individual in reducing it to his exclusive and lawful possession, but, on the contrary, the power of the state follows the game into the hands of the lawful exclusive possessor, and in the assertion of its title held therein in trust for all the people of the state it may so control its use and disposition as to absolutely forbid and prohibit its coming under the protection and control of the commerce clause of the national Constitution. And the reason for the rule is apparent. If the state, either by its laws, or in the absence of prohibitive laws, once permits game to come under the authority of the commerce clause of the national Constitution, then all state control or authority thereover of necessity must cease to exist, and its trust title for the common good of all the people of the state be cut off and destroyed . . .*

Speaking after enactment of the Migratory Bird Treaty Act and before *Missouri* v. *Holland*, the District Court for the Western District of Missouri said:

> *Primarily the state, both as trustee for the rights of all its people and in the exercise of its police power, has control over the right to reduce animals* ferae naturae *to possession. [Citations omitted] And in the absence of treaty there appears to have been no delegation of paramount authority to the federal government. Under the foregoing authorities, therefore, as well as on principle, this act, in the absence of treaty, would be unconstitutional, as exceeding the legitimate powers of Congress, and so it has been held in cases substantially identical. United States v. Shauver, 214 Fed. 154; United States v. McCullagh, 221 Fed. 288. That this power in the state is subject to any valid exercise of authority under the provisions of the federal Constitution is clear; and that a valid exercise of the treaty making power may be recognized as such a valid exercise of authority has been foreshadowed by necessary implication or by express reservation in the decisions of the Supreme Court of the United States. [Citations omitted.]*

Eight years after *Missouri* v. *Holland*, the Supreme Court held that the commerce clause *could* reach shell fish shipped and sold in interstate commerce. In *Foster-Fountain Packing Co.* v. *Louisiana*, 278 U.S. 1 (1928), Foster-Fountain challenged the Louisiana Shrimp Act, which asserted the State's ownership of shrimp within its waters and provided that shrimp caught in its waters must be headed and hulled before being shipped out of the State. Distinguishing this case from *Geer* v. *Connecticut* because the Shrimp Act expressly authorized shrimp meat and bran to be shipped and sold in interstate commerce, the Court said, 278 U.S. at 12:

> *Consistently with the Act all may be, and in fact clearly all is, caught for transportation and sale in interstate commerce. As to such shrimp the protection of the commerce clause attaches at the time of the taking . . . But, in direct opposition to conservation for intrastate use, this enactment permits all parts of the shrimp to be shipped and sold outside the State. The purpose is not to retain the shrimp for the use of the people of Louisiana; it is to favor the canning of the meat and the manufacture of bran in Louisiana by withholding raw or unshelled shrimp from the Biloxi plants.* But by permitting its shrimp to be taken and all the products thereof to be shipped and sold in interstate commerce, the State necessarily releases its hold and, as to the shrimp so taken, definitely terminates its control. *Clearly such authorization and the taking in pursuance thereof put an end to the trust upon which the State is deemed to own or control the shrimp under the authority of the Act necessarily thereby become entitled to the rights of private ownership and the protection of the commerce clause. [Emphasis added.]*

The paramount authority of the commerce clause was challenged again in 1948 when citizens of Georgia sued to enjoin South Carolina State officials from enforcing statutes of that State regulating commercial shrimp fishing in the three-mile maritime belt off the coast.[14] One of the statutes challenged required all boats licensed to trawl for shrimp in the State's waters to dock at a South Carolina port, unload, pack, and stamp their catch before shipping or transporting it to another State. The Court declared this statute unconstitutional. Concurring with the Court's decision, Mr. Justice Frankfurter said, 334 U.S. at 409:

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[14] *Toomer* v. *Witsell*, 334 U.S. 335 (1948).

> *. . . When a State regulates the sending of products across State lines we have commerce among the States as to which State intervention is subordinate to the Commerce Clause. That is the nub of the decision in Foster-Fountain Packing Co. v. Haydel, 278 U.S. 1. South Carolina has attempted such regulation of commerce in shrimp among the States. In doing so she has exceeded the restriction of the Commerce Clause.*

The line to be drawn between the legitimate exercise of the State's police power to regulate the taking and use of animals *ferae naturae,* and the paramount powers of the United States under the commerce clause is not clear. However, the Supreme Court has enunciated certain general principles regarding the States' police power.[15] In each case involving the commerce clause, the courts must balance the adverse effect on interstate commerce imposed by a State law against the local benefits which the law was designed to achieve. In holding that a Maryland law prohibiting the use of purse nets in the tidal waters of the State had a rational basis and that the interference with interstate commerce was "merely incidental," the District Court in *Corsa* v. *Tawes*[16] said:

> *. . . in the absence of conflicting Congressional legislation under the commerce clause regulation of the coastal fishery is within the police power of the individual states . . . Congress has not sought to impose uniformity, but has been content to leave the matter to local authority and has recently made this intention explicit . . [citing the Submerged Lands Act of 1953].*
>
> *Doubtless catching menhaden and processing them into useful products is a legitimate occupation and in commerce the interstate aspects of which cannot be interfered with arbitrarily. But the same Constitution which puts interstate commerce under the protection of Congress recognizes the sovereignty of the states in local regulation for the protection of their natural resources. If the adverse effect on interstate commerce is only incidental and indirect and is outweighed by the local benefits which the statute is designed to achieve, the commerce clause will not render the enactment invalid. . .*

E. Submerged Lands Act

To fill out a consideration of the Federal-State powers to regulate fisheries, attention must be given to the Submerged Lands Act of 1953,[17] which provides in part:

> *It is determined and declared to be in the public interest that (1) title to and ownership of the lands beneath navigable waters within the boundaries of the respective States, and the natural resources within such lands and waters, and (2) the right and power to manage, administer, lease, develop and use the said lands and natural resources all in accordance with applicable State law be, and they are, subject to the provisions hereof, recognized, confirmed, established, and vested in and assigned to the respective States . . .*[18]

The Act defines "natural resources" to include minerals and "fish, shrimp, oysters, clams, crabs, lobsters, sponges, kelp, and other marine animal and plant life . . . "[19] Finally, the Act provides:

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[15] See, for instance, *Huron Portland Cement Co.* v. *Detroit,* 362 U.S. 440 (1960).

[16] 149 F. Supp. 771, 773, 776 (D. Md., 1957), *affirmed,* 355 U.S. 37 (1957).

[17] Act of May 22, 1953, 67 Stat. 29, 43 U.S.C. 1301-1315.

[18] 67 Stat. 31, 43 U.S.C. 1311(a).

[19] 67 Stat. 29, 43 U.S.C. 1301(e).

> *The United States retains all its navigational servitude and rights in and powers of regulation and control of said lands and navigable waters for the constitutional purposes of commerce, navigation, national defense, and international affairs, all of which shall be paramount to, but shall not be deemed to include, proprietary rights of ownership, or the rights of management, administration, leasing, use, and development of the lands and natural resources which are specifically recognized, confirmed, established, and vested in and assigned to the respective States . . .* [20]

We have been unable to find any case law or administrative interpretations of the section quoted immediately above, but would like to make two observations about the section. The effect of *United States* v. *California* was to invest the United States with a proprietary interest, to which Mr. Justice Frankfurter alluded in his dissent.[21] This seems to have been confirmed in *United States* v. *Louisiana,*[22] where the Court stated:

> *Since the Act concededly did not impair the validity of the* California, Louisiana, *and* Texas *cases, which are admittedly applicable to all coastal States, this case draws in question only the geographic extent to which the statute ceded to the States the federal rights established by those decisions. . .*
>
> *While the ownership of certain lands within state boundaries has been held to be an inseparable attribute of the political sovereignty guaranteed equally to all States, . . . the geographic extent of those boundaries, and thus of the lands owned, clearly has nothing to do with political equality.* A fortiori *this is true in the case of maritime boundaries beyond low-water mark, since,* except as granted by Congress, the States do not own the lands beneath the marginal seas. *[Emphasis added.]*

Regulatory authority over natural resources in the navigable waters within the seaward boundaries of the States has not been completely relinquished by the Congress, and could be asserted if necessary to do so in the best interest of rehabilitation of the U.S. fisheries. The "proprietary rights of ownership" and "title" to natural resources granted by the Submerged Lands Act, as they pertain to migratory species of fish, are subject to the limitations previously discussed regarding title to animals *ferae naturae,* which may be part of the meaning of the phrase "if any it has" in 43 U.S.C. 1311 (b), where Congress relinquished "all right, title, and interest of the United States, if any it has, in and to all said. . . natural resources."[23] This also includes relinquishment of the public trust in which the State holds "title" to animals *ferae naturae* once a State permits the shipping and sale of such resources in interstate commerce.[24] Patently, the Congress has not relinquished the power to regulate interstate commerce in recognizing, confirming, establishing, and vesting proprietary rights of ownership and rights of management over such natural resources in the States. Congress could assert regulatory powers pursuant to the Commerce Clause if it found that the failure of the States to manage the marine fisheries imposed an undue burden upon interstate commerce.

F. Conclusions and Summary

Summing up the discussion of the power of the Federal Government to participate in the regulation of United States fisheries, we conclude (1) that when enabled pursuant to a treaty, the Federal Government has clear authority to regulate fisheries, which authority would supervene any State laws on the subject, and which could be exercised exclusively if the Congress were so to choose and (2) that the commerce clause could be invoked to warrant Federal regulation or participation in regulation of species shipped and sold in interstate commerce.

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[20] 67 Stat. 32, 43 U.S.C. 1314.

[21] 332 U.S. 19, 45 (1946).

[22] 363 U.S. 1, 7, 77 (1959).

[23] 67 Stat. 31, 43 U.S.C. 1311(b).

[24] Cf. *Foster-Fountain Packing Co.* v. *Louisiana,* 278 U.S. 1 (1928); *Toomer* v. *Witsell,* 334 U.S. 335 (1948).

In the one case in which Congress sought to regulate migratory birds without a treaty, two District Courts held the Act unconstitutional in the exercise of the States' ownership of animals *ferae naturae* and their police power to regulate the taking and use of such animals. However, subsequent Supreme Court decisions have found that when shrimp are caught for shipment and sale in interstate commerce the trust upon which the State owns or controls the shrimp for the benefit of its people is lost, and the protection of the commerce clause attaches at the time of the taking. The Supreme Court and lower Federal courts have oft stated that in the absence of Federal legislation, the State may regulate the taking and use of migratory species. Despite giving title to "natural resources" in the waters within the boundaries of the States, and Congress' vesting of the right and power of the States to manage the natural resources in accordance with State law under the Submerged Lands Act, the power of Congress to regulate interstate commerce has not been diminished. The proprietary right to the living resources has been affirmed, to the extent it existed, but the authority to regulate interstate commerce has not been relinquished by the Congress.

While asserting that there is ample authority under the commerce clause for the United States to regulate U.S. fisheries, we contend that measures short of Federal regulation can be invoked toward removal of inhibiting institutional barriers, and for the rehabilitation of U.S. commercial fisheries on sound scientific, economic, and legal concepts. The issue of how such change can be achieved is a very sensitive political question that hits at the very roots of American federalism. The question is not whether Congress has the power to create change, but whether Congress will assert the power and how.

II. ORGANIZATIONAL ALTERNATIVES FOR FISHERIES

A. A Statement of Fisheries Problems

1. Federal Authority

Regulation of the fisheries in the United States is exercised by the States under existing law; the Federal Government acts in a research, advisory, and coordinating role. Inasmuch as there has been no substantial change since the following excerpt was included in a Senate Report of the 79th Congress, it is *à propos* here:

> *. . . In the States, the Federal Government acts, for the national interest, as a research, advisory, and coordinating agency wherever several States are concerned with a common conservation problem. It engages in fishery restoration and management activities, including propagation, independently in waters under Federal jurisdiction, and in collaboration with the States in other waters where national interest is involved. It develops and disseminates knowledge about whole fishery resources (i.e., as opposed to local segments of them). It collaborates in the conservation of species shared between the United States and other nations. It promotes the fullest and most widespread utilization of the commercial fish catch, and the achievement of the highest standard of quality of the fishery products.*
>
> *The foregoing is a statement of an ideal. The Federal Government has never done justice to these functions because its fishery conservation agency. . . has never been given broad enough direction by the Congress to permit it to carry out a unified program to suit the needs of the country as a whole. Without a fundamental plan, the Service has evolved by a process of tacking on projects one by one, which have generally been thrust upon it to meet particular crises, often as the result of pressure by special groups. The appropriations to the Service are based principally on the support of these projects. Thus the Federal Service is helpless to execute a dynamic program based on national needs; instead, it can only carry on with its agglomerate of activities inherited from the past, and wait for further crises which its timely services would otherwise have averted. . . .*[25]

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[25] "Fishery Resources of the United States," Sen. Doc. No. 51, 79th Congress, 1st Sess. (1945), Committee on Commerce, at p. 132.

The Congress sought to establish a comprehensive National policy on fish, shellfish, and wildlife resources for the United States in enacting the Fish and Wildlife Act of 1956.[26] In so doing it required the Secretary of the Interior to: (1) develop and recommend measures appropriate to assure the maximum sustainable production of fish and fishery products, (2) study the economic condition of the fishing industry, and make recommendations to the President and the Congress to aid in stabilizing the domestic fisheries, (3) develop and recommend special promotional and informational activities to stimulate consumption of fishery products, and (4) "take such steps as may be required for the development, advancement, management, conservation, and protection of the fisheries resources."[27]

However, in granting authority to the Department of the Interior for the "management, conservation, and protection of the fisheries resources," the Congress did not increase the authority of the Department to regulate fisheries within State jurisdictional bounds. The authority of the Fish and Wildlife Service, and the philosophy under which the Service has operated, are characterized by conducting scientific research, providing financial assistance, conducting economic investigations, and by developing and recommending actions. Absent express authority under a treaty, and with the exceptions of the Black Bass Act[28] and the Sponge Act,[29] the Service does not participate in regulation of fisheries in the territorial and internal waters of the United States.

The philosophy of Federal restraint in fisheries imposes difficulties when an attempt is made to increase the Federal responsibility for fisheries. If a transition is attempted by the Bureau of Commercial Fisheries in which resource conservation is one of several means necessary to achieve economic, legal, and other social objectives, as well as its present role of insuring an optimum supply of fish, the transition will be hampered by budgetary constraints, political pressures, vested interests, and other institutional barriers favoring traditional approaches. With such institutional barriers in mind which favor the status quo, we turn to some of the present organizational inadequacies and attempt to project certain needs and trends of the United States fishing industries, in order to fulfill the Congressional mandate to develop a coordinated, comprehensive program for "rehabilitation of our commercial fisheries."

2. Federal-State Interaction

The United States fisheries operate in a difficult institutional climate, both State and Federal, which tends to restrict operations, and to restrict the harvesting segment of the industries from purchasing materials and equipment at the lowest cost. These institutional barriers include:

–State laws that tend, in the name of conservation, to promote inefficiency in the harvesting of fishery resources by (a) restricting fishing operations, vessels, gear, and equipment, (b) creating a patchwork of laws and regulations, varying from State to State, designed to give "economic" advantage to local fishermen over fishermen from other States, and which tend to increase the rivalry between States sharing a common fishery and decrease the likelihood of the States initiating joint management efforts, and (c) failure to regulate fishing effort at levels which the resource can sustain, without affecting efficiency. The institutional climate is further complicated by the fact that the restrictions are often requested or demanded by the groups whose activities they restrict or by competing groups which have the political strength to influence the legislative or regulatory imposition of such restrictions.

–Federal laws, such as the prohibition against the landing of fish in foreign hulls, or limitations of the purchase of foreign fishing gear and equipment.

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[26] Act of August 8, 1956, 70 Stat. 1119, as amended, 75 Stat. 788 (Oct. 4, 1961), 76 Stat. 849 (Oct. 11, 1962), 16 U.S.C. 742a-742k.

[27] 16 U.S.C. 742f.

[28] Act of May 20, 1926, 44 Stat. 576, as amended, 16 U.S.C. 851-856.

[29] Act of August 15, 1914, 38 Stat. 692, as amended, 16 U.S.C. 781-785.

–Preferential treatment of nonfishery products in the tariff structure, and nontariff controls which are not applied to the benefit of the U.S. fishing industries.

Much research is required to assess the impact of local, State, and Federal laws regulating commercial fisheries activities, particularly regarding the efficient and beneficial use of labor and capital in the harvesting segment of those industries. In addition, studies should be undertaken of the effects of broad U.S. trade policies and other government actions on domestic commercial fishing industries. Such research and studies are a desirable precursor to specific detailed recommendations for reorganization of fisheries management arrangements.

In addition to the barriers already named the evidence that we have collected indicates that some portion of the difficulties contributing to the stagnation of many of the commercial fishing industries in the United States is attributable to organizational inadequacies, particularly at the interstate and Federal levels.

We have not found a single instance where two or more States have initiated coordinated measures and have carried them out for the efficient management of migratory marine species. The history of three regional Marine Fisheries Commissions shows that they have not initiated binding, comprehensive plans for specific endangered fisheries. Nor is there indication that the States individually can initiate efficient fishing exploitation practices of endangered migratory species based on sound scientific, economic, and legal concepts for the range of migratory species makes individual State action ineffective if other States having jurisdiction over a part of the migration range do not join in the managerial effort.

The Resources Panel has concluded that the role of the Federal Government must be reoriented toward resource development and the concentration of manpower and financial resources on National fisheries missions. Studies of fishing management and regulatory concepts must be undertaken and new management techniques instituted calling for increased coordination among the States, and a greater Federal role in determining National fisheries policies and priorities. With these goals in mind, we now turn to discussion of alternative institutional arrangements under which the needs might be met.

B. Alternative Institutional Arrangements

1. Marine Fisheries Commissions

a. Atlantic States Marine Fisheries Commission While administering fisheries under the principles noted in Part I, the coastal States have found need for interstate cooperation and advice. The grandfather of interstate compacts for marine fisheries was the Atlantic States Marine Fisheries Compact,[30] formed in 1942 and since 1949 comprised of all of the States of the Atlantic Seaboard from Maine to the Atlantic coast of Florida. The Compact created an Atlantic States Marine Fisheries Commission, composed of three representatives from each member State; the executive head of the State agency charged with conservation of fisheries resources, a member of the State legislature, and an interested citizen.[31] The purpose of the Commission is:

to promote the better utilization of the fisheries, marine, shell and anadromous of the Atlantic seaboard by the development of a joint program for the promotion and protection of such fisheries, and by the prevention of the physical waste of the fisheries from any cause.[32]

It is charged with inquiring into and ascertaining methods, practices, circumstances and conditions for bringing about the conservation and the prevention of the depletion and physical waste of the fisheries of the Atlantic seaboard, with power to recommend the coordination of the exercise of the police powers of the several States.[33] It is to draft and recommend legislation dealing with the conservation of the marine, shell, and anadromous fisheries of the Atlantic seaboard,[34] and consult with and advise the State administrative agencies regarding problems connected with the fisheries, recommending adoption of such regulations as deemed advisable.[35] The Act designated the Fish and Wildlife Service to act as the primary research agency of the Commission, cooperating with the research agencies in each State.[36] Nothing in the compact is to limit the powers of any signatory State or to repeal or prevent the enactment of any legislation or the enforcement of any requirement by any signatory State imposing additional conditions and restrictions to conserve its fisheries.[37] Annual appropriations to the support of the Commission are made in proportion to the primary market value of the products of the State fisheries, exclusive of cod and haddock, with a minimum contribution of $200 per year.[38] The budget of the Commission is in the range of $25,000 to $30,000 per year. Congress has reserved the right to alter, amend, or repeal the provisions of the Act.[39]

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[30] Act of May 4, 1942, 56 Stat. 267, as amended, 64 Stat. 467 (Aug. 19, 1950).

[31] *Id.*, art. III.

[32] *Id.*, art. I.

In 1950, the Congress consented to Amendment No. 1 to the Compact which provided that any two or more of the consenting States could designate the Commission as a joint regulatory agency with such powers as they may jointly confer for the regulation of the fishing operations of the citizens and vessels of the designating States regarding specific fisheries in which such States have a common interest.[40] To date, no States have designated the Commission as a joint regulatory agency.

b. Pacific Marine Fisheries Commission The Atlantic States Marine Fisheries Compact was followed in 1947 by the Pacific Marine Fisheries Compact.[41] California, Oregon, Idaho, and Washington are the members of this Compact; consent to the membership of Hawaii and Alaska was given in the first amendment, but Hawaii and Alaska have not yet joined. Unlike the Atlantic States Compact, which provides that the Fish and Wildlife Service shall be the primary research agency, this Compact provides that the fisheries research agencies of the signatory states shall act in collaboration as the official research agency of the Pacific Marine Fisheries Commission.[42] Also unlike the Atlantic States Compact, the Pacific Marine Fisheries Compact does not provide that the Commission could act as a joint regulatory agency for two or more consenting States. Otherwise, there is no substantive difference between this and the Atlantic States Compact.

c. Gulf States Marine Fisheries Commission The third regional compact, the Gulf States Marine Fisheries Compact, was created in 1949.[43] Members of the Gulf States Compact are Florida (Gulf coast), Alabama, Mississippi, Louisiana, and Texas. Except that the Congress did not expressly reserve the right to amend, alter, or repeal this Act, the Act does not differ substantively from the Atlantic States Marine Fisheries Compact.

Each of the three marine fisheries commissions is completely advisory, established as a formal forum of State legislative and administrative action. While the Atlantic and Gulf States Marine Fisheries

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[33] *Id.*, art. IV.

[34] *Ibid.*

[35] *Ibid.*

[36] *Id.*, art. VII.

[37] *Id.*, art. IX.

[38] *Id.* art. XI.

[39] *Id.*, §4.

[40] Act of August 19, 1950, 64 Stat. 467.

[41] Act of July 24, 1947, 61 Stat. 419, as amended, Act of October 9, 1962, 76 Stat. 763.

[42] 61 Stat. 420, art. VII.

[43] Act of May 19, 1949, 63 Stat. 70.

Commissions may be designated as a joint regulatory agency, no States have done so. One commentator has surmised:

> *. . . The intention seems to have been to sanction formal, although ineffective, power in the interstate agency to regulate the marine fisheries, allowing the fishing industry to brand attempts to establish controls through other institutions as duplicating the Commission's efforts.*[44]

Being wholly advisory, enforcement of fisheries laws and regulations continues to be the responsibility of the officials of the separate member States. Says Barton:

> *Since commercial fishery groups generally enjoy effective access to the legislatures of the coastal states, retention in the state of jurisdiction over fisheries in effect virtually eliminates the possibility of regulations that are not desired by commercial fisherman. . .* [45]

While vigorously advocating no outside regulation of fishing, the Commissions have been instrumental in obtaining authorizations, appropriations, research, and other services from the National Government; have promoted fishery research of mutual interest to both sports and commercial fishermen; recommended uniform laws; and within the limited authority of the compacts, attempted to promote interstate cooperation in the marine fisheries. Federal research, while promoted through the commissions, is, in fact, either performed directly by the Bureau of Commercial Fisheries, or through State agencies, universities, or other research institutions, not through the Marine Fisheries Commissions.

It must be noted that it was never the intention of the three marine fisheries compacts to provide more than advice and recommendations to the member States and to the National Government. The compacts were not intended to regulate fisheries in their respective regions, but, rather, regulation was left to the States, as already mentioned, although two compacts were amended to permit such regulation.

2. Federal Management of Migratory Birds

Turning to other alternatives for the regulation of living resources, there exist examples of Federal assertion of jurisdiction in the analogous area of migratory birds, noted in the first section of this paper. A brief description of the Migratory Bird Treaty and the Migratory Bird Conservation Act follow.

a. Exclusive Federal Jurisdiction Migratory Bird Treaty, Act of July 3, 1918, 40 Stat. 755, as amended, 49 Stat. 1555, (June 20, 1936), 16 U.S.C. 703-711, 50 C.F.R. 10, 15, 16. Under its treaty and commerce powers,[46] Congress has provided that except as permitted by regulation, it is unlawful to hunt, capture, kill, purchase, ship, export or import, etc., any migratory bird included in the terms of the conventions between the United States and Great Britain, 39 Stat. 1702 (Aug. 16, 1916), and the United States and the United Mexican States, 50 Stat. 1311 (March 15, 1937).[47] The Act authorizes and directs the Secretary of the Interior to adopt suitable regulations governing the taking of migratory birds.[48] It further provides that nothing in the Act shall be construed to prevent the States from making or enforcing law or regulations not inconsistent with the provisions of the conventions, or from making or enforcing laws or regulations giving further protection to migratory birds, if the open seasons provided in the Federal regulations are not extended.[49]

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[44] Barton, *Interstate Compacts in the Political Process,* University of North Carolina Press, 1967, p. 28.

[45] *Ibid.*

[46] *Bailey* v. *Holland,* 126 F.2d 317 (1942).

[47] 16 U.S.C. 703.

[48] 16 U.S.C. 704.

[49] 16 U.S.C. 708.

The Regulations promulgated by the Secretary list the migratory birds included in the terms of the conventions,[50] prescribe hunting methods[51] and open seasons,[52] set conditions and restrictions for transportation and importation,[53] and place restrictions applicable to possession.[54] The schedules for seasons and limits designate the areas open to hunting, often broken down by counties within the States, the respective open seasons, the shooting hours, and the daily bag and possession limits.[55]

Responsibility for administration of the Migratory Bird Treaty has been delegated to the Director of the Bureau of Sport Fisheries and Wildlife, who works in coordination with the States, Canada, and Mexico to manage and enforce the Treaty.

With respect to migratory waterfowl, data gathering and surveys are conducted by roughly 50-55 field personnel of the Bureau, with the help of perhaps 40 States' employees. About 200 Federal and State employees are involved in banding of migratory birds, another measure in the management of the birds. Finally, enforcement is accomplished by 150-160 Federal wardens under the Bureau, strongly assisted by approximately 4,500 State wardens, many of whom have been deputized as Federal wardens.

Annually the Bureau meets with two types of advisory groups and with the Congress, to present the results of their research and to make staff recommendations for regulations for the coming year. In early August, the Bureau meets with the Flyway Councils, which are comprised of official State government representatives, and with Waterfowl Advisory Committees, which represent a broad segment of the public interest (conservation groups, etc.) plus representatives from the Flyway Councils. Recommendations are made by both advisory groups to the Director of the Bureau. Thereafter, in a practice instituted in recent years, the Congress will hold hearings on the recommendations, and the recommendations of Congress will also be joined to those previous. Finally, recommendations for regulations are made to the Secretary of the Interior, and, if accepted, are published in the Federal Register.

At present the Federal program costs approximately $3,500,000 annually, including data gathering and surveys, data analysis and research, banding, and enforcement. Indications are that the Canadians will assume the responsibility for conducting surveys and gathering data in the next few years.

b. Federal Jurisdiction, State Participation Migratory Bird Conservation Act, Act of February 18, 1929, 45 Stat. 1222, 16 U.S.C. 715a-715s, 50 C.F.R. 25-34. This Act creates and authorizes the Migratory Bird Conservation Commission, consisting of the Secretary of the Interior, the Secretary of Commerce, the Secretary of Agriculture, two Members of the Senate, and two Members of the House of Representatives, to consider and pass upon any area of land, water, or land and water recommended for purchase or rental for the conservation of migratory birds.[56] The ranking officer of the State government unit administering its game laws, or the Governor if there is no such unit, shall be a member *ex officio* of the Commission for the purpose of considering and voting on all questions relating to the acquisition of areas in his State under this Act.[57] No deed or instrument of conveyance can be accepted under the Act unless the State in which the area lies has consented by law to the acquisition by the United States of lands in that State.[58] Acquisition and administration of migratory bird reservations by the United States does not affect or change the State's jurisdiction, both civil and criminal, over persons in the reservations, except as concerns punishment of offenses against the United States.[59] Nor does the

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[50] 50 C.F.R. 10.1.

[51] 50 C.F.R. 10.3.

[52] 50 C.F.R. 10.4, 10.41-10.54.

[53] 50 C.F.R. 10.6-10.8.

[54] 50 C.F.R. 10.9-10.14.

[55] 50 C.F.R. 10.41-10.54.

[56] 16 U.S.C. 715a, 715c.

[57] 16 U.S.C. 715a.

[58] 16 U.S.C. 715f.

[59] 16 U.S.C. 715g.

Act interfere with State game laws insofar as they do not permit what is forbidden by Federal law.[60] When the State makes provision by legislation adequately to enforce the provisions of the Act and its regulations, the State may cooperate with the Secretary of the Interior in the enforcement of the Act and its regulations.[61] The States share 25 per cent of the revenues derived from the sale of surplus wildlife, timber, hay, grass, etc., and from concessions and other privileges, the money to be paid to the counties in which the refuge is situated and to be expended for the public schools and roads of those counties.[62] In addition, the counties receive 3/4 of 1 per cent of the adjusted cost of the areas, exclusive of improvements subsequent to Federal acquisition, or 25 per cent of the net receipts collected from such acquired lands within the counties, whichever is greater.[63]

There are no regulatory or management functions performed by the Commission; its responsibilities are to consider and pass upon the land acquisition program for conservation of migratory birds of the Secretary of the Interior. The program is financed from the sale of "Duck Stamps" and by appropriations from Congress. "Duck Stamp" sales presently account for approximately $5,000,000 in annual revenue. In 1961 the Congress authorized appropriation of $105,000,000 over a seven-year period, on condition that at the end of the period, the appropriations would be repaid to the U.S. Treasury at the rate of three-quarters of the annual "Duck Stamp" receipts. Without increasing the authorization, the Congress has extended the term to 1976, upon the same repayment conditions.

3. Water Resources Council Survey

The Marine Fisheries Commissions, the Migratory Bird Treaty, and the Migratory Bird Conservation Act, represent but a small portion of the number of institutional arrangements that can be established for promoting Federal, State, and local interests in living resources. Many methods exist for accomplishing interstate, intrafederal cooperation, ranging in degree of legal effect and formality. Among others these include reciprocal laws, uniform State laws, grants-in-aid, tax credits, administrative agreements, interstate compacts, and judicial settlement of interstate disputes.[64] The Water Resources Council has made a useful study of eight different institutional arrangements that reflect a wide range of powers and functions. That study included consideration of (a) interstate compacts, (b) Federal-interstate compacts (Delaware River Basin Commission), (c) river basin commissions (Potomac River Basin Commission, etc.), (d) basin inter-agency committees, (e) regional Federal-State commissions (Appalachian Regional Commission), (f) intrastate special districts, (g) the Federal regional agency (TVA), and (h) the single Federal administrator (Colorado River). While directed toward the problems of river basin management, nevertheless study of the various institutional arrangements provides interesting and useful analogies to the problems confronting Federal, State, and local governments in management of the United States fisheries. In summary form we have set out below some of the salient characteristics of five of the institutional arrangements as they might apply to fisheries.

a. Interstate Compacts A wide range of powers, functions, and flexibility can be built into interstate compacts. They vary from the purely advisory functions of the marine fisheries commissions to operational control of extensive and highly complex areas, such as the Port of New York Authority. The

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[60] 16 U.S.C. 715h.

[61] 16 U.S.C. 715p, 50 C.F.R. 253.

[62] 16 U.S.C. 715s(c)(1), 50 C.F.R. 34.4(a), 34.5.

[63] 16 U.S.C. 715s(c) (2), 50 C.F.R. 34.4(b).

[64] "The Interstate Compact Since 1925," by Frederick L. Zimmermann and Mitchell Wendell, Council of State Governments, Chicago, 1951, contains an excellent discussion of the evolution of interstate compacts, their legal effect, problems of enforcement, and national participation, compacts with foreign powers, and the place of compacts in American federalism. For another report summarizing various forms of interstate and Federal cooperation, see "Selected Materials on Federal-State Cooperation in the Atomic Energy Field," Joint Committee on Atomic Energy, 86th Cong., 1st Sess., March 1959, and the paper therein prepared by the Council of State Governments, entitled "Intergovernmental Relationships in Fields Other Than Atomic Energy."

Federal Government is not a signatory to such compacts, but may participate as observer or as nonvoting chairman or member. Federal participation is normally desirable, as a minimum, to provide liaison with Federal programs related to the problems confronting the States in fisheries management. The commission established under the interstate compact could coordinate appropriate programs that concern the States and the Federal Government in fisheries development and management. If deemed desirable, the compact commission could be given broad and flexible regulatory powers. As noted above, two of the marine fisheries commissions have been authorized to carry on regulatory functions, but no States have delegated such authority to either commission. The compact commission could perform needed studies (such as review of State laws and regulations); make recommendations for action (such as removal of institutional barriers); or make expenditure of funds appropriated or granted to it contingent upon adherence by the States to policies established by it or the grantor.

b. Federal-Interstate Compacts (e.g., Delaware River Basin Compact) The principal differing characteristic between the Interstate Compact and the Federal-Interstate Compact is the full status as partner-participant that the Federal Government has in the latter arrangement. Otherwise, all potential characteristics of the interstate compact could be incorporated into such a compact. The principal advantage to the Federal Government would be its stronger position in the compact as a voting member. There is no particular voting formula that must be applied in such compacts. Decisions in the Delaware River Basin Commission are by majority vote of the members. However, other voting procedures could be adopted, depending upon the respective roles of the members.

c. Regional Federal-State Commissions The most notable example of a regional Federal-State Commission is the Appalachian Regional Commission (ARC). Decisions by the ARC are by affirmative vote of the Federal Co-chairman and a majority of member States. The Commission's greatest strength lies in its ability to obtain cooperation, in part owing to its control of the expenditure of substantial Federal funds in the region. All programs seeking assistance under the Appalachian Regional Development Act must have the Commission's approval. Noteworthy is the fact that the Commission has no authority to regulate, nor to operate and maintain projects. Planning is done by the operating agencies at the State and local level, reviewed by staff of the Commission which must apply Federal criteria where applicable, and otherwise apply the policies, priorities, and criteria established by the Commission.

d. Federal Regional Agency This type of agency is typified by the Tennessee Valley Authority. TVA was, and is, unique as a single Federal agency assigned responsibility to plan and operate a multiple-purpose development of a complete river system. Basically, TVA is a Federal undertaking, a fact that is not diminished by the numerous arrangements with States and local governments for coordinating their planning activities with those of the TVA. The basic river development program is financed principally by Federal appropriations, although in 1959 it was authorized to sell revenue bonds and use other borrowed funds to finance its power operations, a vendible product.

However, the TVA has no power to regulate State and local programs, authority for which rest either with the States or with Federal regulatory bodies.

e. Single Federal Administrator The single example of single Federal administration of a river basin is the regulation of the Colorado River by the Secretary of the Interior. The Secretary has broad regulatory powers over the main stream of the Colorado River for flood control, water supply, power generation, recreation, and fish and wildlife. Financed solely by Federal appropriations, the Colorado River operations are subject to Congressional authorization. There is no formal State participation in comprehensive river basin planning.

4. Federal Water Pollution Control Act

The Federal Water Pollution Control Act[65] declares a National policy for the prevention, control, and abatement of water pollution. While recognizing and preserving the primary responsibilities and rights of the States in preventing and controlling water pollution, the Act gives the Federal Government, through the Department of the Interior, significant powers ranging from the development of comprehensive programs for eliminating or reducing pollution to enforcement of standards for water quality.

Under the Act, the Secretary of the Interior prepares and develops comprehensive programs noted above, in cooperation with other Federal agencies, State water pollution control agencies, and with municipalities and industries involved. The Secretary has authority to make grants to cover 50 per cent of the administrative expense of planning agencies established to develop a comprehensive pollution control and abatement plan. Grants are also made for construction of municipal waste treatment works, and are available to demonstrate new or improved methods of control of waste discharges from storm sewers or storm and sanitary systems. The Secretary has been given authority to conduct and to encourage public and private agencies to conduct research, investigations, and studies related to the causes, control and prevention of water pollution, including establishment of research fellowships, field laboratories, and research facilities.

Under the Act the States are to establish their own water quality standards, consistent with Federal criteria, and, if they fail to do so, the Secretary of the Interior is authorized to prepare regulations setting forth water quality standards. The water quality standards so established become the standards applicable to the particular interstate waters involved, and the discharge of matter into those waters which reduce the quality of the water below the established water quality standards is subject to abatement. The Act provides various means for abating pollution, ranging from administrative procedures such as withholding of Federal payments for noncompliance with the water quality standards, to conferences, and administrative public hearings, and if these fail, it provides for judicial action on behalf of the United States to secure abatement of the pollution.

C. Organizational Alternatives

1. Foreword

The many different combinations used to solve problems of river basin management and water pollution control point also to the prospect that no single institutional arrangement will solve all the organizational problems of the U.S. fisheries. The evidence available is convincing, however, that the present role played by the Federal Government and the marine fisheries commissions is inadequate to meet the needs of rehabilitation of the harvesting segment of the U.S. fishing industries, and that new organizational arrangements are required if fisheries expansion possibilities are to be attacked on species or regional bases as part of comprehensive resource development programs.

History shows that the three marine fisheries commissions, under their present advisory compact structure, have not initiated binding, comprehensive plans for specific fisheries that are endangered by overexploitation. Individual States often do not have jurisdiction over the full range of migratory species, and have yet to institute sound fishing practices when other States having jurisdiction over part of the migration range refuse to participate in a joint regulatory effort. If anything, under the present patchwork of different State fisheries laws and regulations, rivalry between the States is promoted, not interstate cooperation. The scope of the research to be done, the Federal and State cooperation required, and the impact upon the economy are regional and National in scale. The States can be given opportunity and incentive to promote the efficient development of our commercial fisheries under their jurisdiction, and to amend and correct their institutional barriers that inhibit the prosperity of many of our commercial fisheries. But if they were to fail, there is ample authority under both the treaty and commerce clauses of the Constitution for the Congress to increase the Federal regulatory role in fisheries.

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[65] Act of July 20, 1961, 75 Stat. 204, as amended, Act of October 2, 1965, 79 Stat. 903, 33 U.S.C. 466.

The Resources Panel has not recommended any one organizational arrangement for fisheries management. Rather, the panel concluded that detailed regional or species-oriented studies of the impact of Federal, State, and local institutional barriers would be desirable before any reorganization attempt be made, and we commend the efforts of the Bureau of Commercial Fisheries to begin such studies. The panel has stated, however, that new management techniques should be instituted calling for increased coordination among the States and a greater Federal role in determining National fisheries policies and priorities. We suggest below the broad outlines of three organizational arrangements that could promote coordination among the States and a greater Federal role, details for which would have to be filled in as part of a concerted effort to create new fisheries management arrangements.

2. Regional Compact for Economic Development

a. Under a regional compact for economic development, the marine fisheries compacts could be amended to strengthen the roles both of the marine fisheries commissions and the Federal Government with regard to the U.S. commercial fisheries.

b. Toward establishment of a regional compact to strengthen the roles of the commissions and the Federal Government, the following features would be appropriate:

–Regulation of marine fisheries in the territorial and internal waters of the United States remain in the States, as at present;

–The marine fisheries compacts could be amended to make the Federal Government a signatory member of the compacts, in addition to the States;

–Decisions of the marine fisheries commissions could be based upon the affirmative vote of the Federal Government representative and a majority of the member States;

–The staffs of the marine fisheries commissions could be augmented to include planning and coordinating competence;

–Administrative expenses of the marine fisheries commissions could be paid 50 per cent by the Federal Government and 50 per cent by the States;

–Federal monies for scientific research, economic investigations, and other programs which, under present law, are expended by or in the States, could be placed in the control of the marine fisheries commissions, to be expended in accordance with the National fisheries policies and priorities established by the Federal Government;

–The States should have primary responsibility for developing plans and programs for expenditure of Federal funds, in accordance with the national fisheries policies and priorities established by the Federal Government;

–The marine fisheries commissions could be empowered to enter contracts and to make grants, cooperative agreements, or other arrangements necessary to carry out their functions;

–The marine fisheries commissions could be financed solely by appropriations, contracts, or grants from the Federal Government and member State governments. Member State governments in arrears of their allocable share, should not be eligible for Federal financial assistance.

c. The Federal Government should sponsor detailed review and analysis of the impact of Federal, State, and local institutional barriers inhibiting development of U.S. commercial fisheries.

3. Federal-State Cooperation Modeled after the Federal Water Pollution Control Act

a. Regulation of marine fisheries in the territorial and internal waters of the United States would remain the primary responsibility and right of the States;

b. Act would be administered by the Fish and Wildlife Service, and would require the Service to establish priorities and fishery policies for the development and utilization of migratory marine species for commercial and recreational purposes, in cooperation with other Federal agencies, and with State and interstate agencies;

c. Would encourage cooperative activities by States for regulation and conservation of migratory marine species; encourage enactment of improved and uniform State laws relating to the regulation and conservation of such species;

d. Fish and Wildlife Service would continue to perform scientific research, would strengthen its economic research and technological research, and would provide for continuing studies of laws, regulations, and institutional arrangements within States regarding the conservation, regulation, and utilization of fish and fishery resources;

e. Would authorize: grants up to 50 per cent of the administrative expenses of State and interstate planning agencies; grants for research and development (such as through amendment of the Commercial Fisheries Research and Development Act, Anadromous and Great Lakes Fisheries Act, and Federal Aid in Fish Restoration Act); and grants to assist the States, interstate and international agencies to meet the costs of establishing and monitoring measures for regulation, conservation, and utilization of migratory marine species.

f. The Act would require States to submit plans for regulation, conservation, development, and utilization of marine fisheries, which plans would include the methods for implementation of the State fisheries plans in accordance with Federal policies and priorities for resource development, and would include identification of institutional barriers inhibiting efficient development and use of the fisheries, and the steps proposed to be taken by the State to remove them. Once accepted by the Federal Government as the State plan, Federal grants mentioned above could be made. Should the State change the plan without Federal approval, or fail to comply with its provisions for reasons unacceptable to the Federal Government, the Federal Government would be authorized to withhold payments to the State.

g. The Act would provide administrative procedures for enforcement of the State plans in accordance with Federal policies and priorities. It would provide that if the States fail to act to make plans for the regulation, conservation, development, and utilization of its marine fisheries, the Secretary of the Interior could do so, and the Secretary could take necessary steps to enforce those regulations.

4. Regional Compact with Enforcement Powers

A third alternative which we suggest, represents an amalgam of the regional compact for economic development and the enforcement procedures and powers of the Federal-State cooperative efforts discussed immediately above.

a. Regulation of marine fisheries in the territorial and internal waters of the United States would remain the primary responsibility and right of the States;

b. The marine fisheries compacts would be amended to make the United States of America a signatory member of the Compacts, in addition to the States;

c. Decisions of the marine fisheries commissions, formed under the Compacts, would be based upon the affirmative vote of the Federal representative and a majority of the member States;

d. The staffs of the marine fisheries commissions would be augmented to include planning and coordinating competence;

e. Administrative expenses of the marine fisheries commissions could be paid 50 per cent by the Federal Government and 50 per cent by the States;

f. That Federal monies for scientific research, economic investigations, and other programs, which under present law or under legislation hereafter enacted, are to be expended by or under the authority of the States (such as the Commercial Fisheries Research and Development Act, and the Anadromous and Great Lakes Fisheries Act) be placed in the control of the marine fisheries commissions, to be expended in accordance with national fisheries policies and priorities established by the Federal Government, and in accordance with the priorities, policies, and procedures of the marine fisheries commissions;

g. The States would have primary responsibility for developing plans and programs for expenditure of Federal funds, in accordance with the National fisheries policies and priorities established by the Federal Government. The States would submit to the marine fisheries commissions their plans for regulation, conservation, development, and utilization of marine fisheries, which plans would include identification of institutional barriers inhibiting efficient development and use of the fisheries, and the steps proposed to be taken by the State to remove them. Should the State change its plan without marine fisheries commission approval, or fail to comply with the provisions of the plan, the marine fisheries commission would be authorized to withhold payments to the State;

h. Administrative procedures for enforcement of State plans in accordance with marine fisheries commission and Federal policies and priorities would be provided. It would provide further that if the States fail to act to make plans for the regulation, conservation, development, and utilization of its marine fisheries, the Secretary of the Interior, working in cooperation with the marine fisheries commission, could do so, and the Secretary could take necessary steps to enforce those regulations.

5. Discussion of Alternative Institutional Arrangements

a. Under the current mechanisms for dealing with fisheries problems, little can be done to promote management of U.S. fisheries on sound scientific, economic, and legal bases. Many of the State institutional barriers that inhibit sound fishing practices, also inhibit action by the States to correct the situations. Almost all State fisheries administrators to whom we have spoken have indicated both an awareness of the problems confronting commercial fisheries and a desire to correct them, but under the present mechanisms are unable to overcome the political and other institutional barriers in their States that inhibit change. The alternatives presented above provide a stronger Federal role, initially through economic incentives brought to bear upon the States through either the marine fisheries commissions or the Bureau of Commercial Fisheries. Two of the alternatives go beyond economic incentives to assert a potential Federal regulation of the fisheries if administrative procedures provide insufficient incentive to the States to move toward sound fisheries management.

b. The institutional arrangements suggested here presuppose initially that the changes required could be accomplished without divesting the States of the regulatory authority that they have traditionally exercised over marine fisheries. Under the regional compact, the principal role of the marine fisheries commissions would be that of economic development and would not place any regulatory authority in the marine fisheries commissions. Rather, through the exercise of other powers, it would be the purpose of the regional compact to encourage and facilitate change by the States, with the sanction of withholding Federal funds for failure to effect sound fisheries management policies and programs. Both the Federal-State partnership and the regional compact with enforcement powers assume that economic pressure may be insufficient to effect the necessary changes, and that only the ultimate sanction of Federal preemption of regulation of the marine fisheries will provide the necessary power-incentive for the States to begin to remove the institutional barriers inhibiting the sound management of marine fisheries.

c. Under the two regional compacts suggested, substantial Federal funds for fisheries would be placed in the control of the strengthened marine fisheries commissions. In order to protect and promote the interests of the United States under such arrangements, the Federal Government must be a signatory member of the marine fisheries compacts, with full voting rights, and an ultimate veto if it disagrees with programs proposed before the marine fisheries commissions. Basic to the operations of the marine fisheries commissions under the regional compacts would be the responsibilities of the member States, which would pass upon the programs of individual States and would have a voice in the programs of other States not now present.

d. Successful execution of the suggested changes requires augmented staffs, either of the marine fisheries commissions under the regional compacts or of the Bureau of Commercial Fisheries, reflecting the increased responsibilities for planning and coordinating that they would assume under the new arrangements. Under the regional compacts, the staffs of the commissions would be required to work closely both with the States and with the Federal Government preparing and reviewing plans, conducting studies, administering funds, and making recommendations to the commissions to pass upon. Whether additional administrative layers and additional administrative costs are warranted would have to be determined by the States and by the Congress. Under the FWPCA model, the planning, reviewing, and coordinating role would be assumed by the Federal Government, working directly with individual States.

e. The expense of administration under all three alternatives would be increased, and we believe that it would be in the best interests of the Federal Government to assume a major portion of the increased expense. We have suggested 50 per cent of the administrative expenses of the reconstituted commissions would be an appropriate Federal share of the administrative expenses under the regional compacts, as a minimum. Nevertheless, we anticipate that the States' contributions to the administration of the regional compacts would be substantially increased over their present contributions to the marine fisheries commissions. As an incentive for establishing the commissions, the Federal Government might be authorized to pay 100 per cent of the administrative expenses for two years or some other definitely limited time. Under the FWPCA model, the Federal Government would assume 100 per cent of the increased expense.

f. As previously alluded to, the power of the new marine fisheries commissions would lie in their control of substantial sums of Federal monies for fisheries research and development, with explicit power to withhold the monies were the States to refuse to act in accordance with the plans that would be adopted, or with the policies and priorities set both by the Federal Government and by the commissions in conjunction with the Federal Government. Should the economic incentives prove ineffective to achieve the goals defined, the administrative procedures outlined and the enforcement powers would be invoked by the Federal Government under both the FWPCA model and the regional compact with enforcement powers.

g. Under all three alternatives, the States would still have primary responsibility for planning and administering their State fisheries programs. The planning staff should be directly responsible and accessible to the highest official in the State responsible for administering the fisheries; the planning function should be a continuing and integral part of the State budgetary function. The plans developed should also serve to assist the State legislature in developing policies and laws, particularly with regard to removal of institutional barriers to sound fisheries management.

h. Removal of the institutional barriers inhibiting growth of the American fishing industries and recommendations for sound fisheries management will require studies by many different disciplines–the biological, chemical, and physical oceanographic sciences, and the social sciences of economics, political science, and law. The Bureau of Commercial Fisheries, working in conjunction with State governments, the fishing industries, and the academic community, should undertake these studies on regional or species bases as appropriate as a precursor to recommendations to State legislatures and to the Congress to amend or repeal laws and policies inhibiting fisheries development, and as a precursor to reorganization of interstate or Federal-State cooperative efforts for rational management of fishery resources.

FINDINGS AND RECOMMENDATIONS

Currently available data indicate that with a few exceptions such as gold, silver, and uranium the worldwide physical supply of land-based hard mineral resources is sufficient to meet projected demands at least to the year 2000.

This judgment, however, is based on the assumptions that sporadic new land-discoveries will be made at a normal rate and that a constantly improving technology will permit the extraction of lower grade resources. It is also assumed that international political conditions will remain relatively stable and that the United States will be able to continue to import the fairly extensive group of mineral commodities that are not available from domestic sources, including off-shore sources.

If these assumptions are accepted it appears that there will be no pressing necessity to turn to marine sources for hard minerals during the next two or three decades. Of course some companies, with particular needs for certain types of mineral reserves, may have an incentive to pioneer the development of some marine resources sooner than might otherwise be expected.

Although a crash program to find and develop marine mineral resources is not deemed necessary, a substantial and continuing National effort should be initiated to pave the way for a broadening of the resource base for the next generation to obviate a future crash program and to enhance the opportunities for exploiting minerals from marine sources over the near term.

There are now opportunities to obtain certain mineral commodities from the marine environment more cheaply than from land-based sources. Sand, gravel, and calcium carbonate raw material, in short supply in some urban areas, are being dredged from the continental shelves, often with multiple benefit effects. Elemental sulphur is being obtained by the efficient Frasch process from offshore sources in the Gulf of Mexico. Salt, magnesium, and bromine are extracted in substantial quantities from sea water; tin, iron ore, coal, and other mineral commodities are mined successfully from the seabed in other parts of the world. Additional opportunities for economic exploitation of minerals from marine sources will inevitably appear. Gold and other heavy minerals offer immediate potential; among the more distant possibilities are phosphorite nodules, manganese nodules, and other minerals.

In order to improve these opportunities and to help broaden the Nation's overall mineral resource base a National program involving mapping and charting, scientific and technologic research, and review and revision of some of the existing laws and regulations should be initiated as soon as possible because the lead time for achieving some of the program objectives is fairly long.

The following specific findings and recommendations should be considered in the overall context of enhancing and expanding economic opportunity at a deliberate pace rather than in the context of an urgent or immediate necessity. Some of the findings are similar to those in the President's Science Advisory Committee report of 1966, although rather different approaches have been followed in arriving at them.

A. Mapping and Geologic Research

Bathymetric charts showing the contour of the sea floor are, like topographic maps on land, the base on which many other types of information are plotted. It is essential that good bathymetric charts be available if other information, such as distribution of geologic formations and structures and delineation of mineral deposits are to be analysed and interpreted in a meaningful way.

Recommendation:

Bathymetric charts at 1:250,000 scale should be completed for the entire U.S. continental shelves and slopes within 15 to 20 years by a Government agency. Reconnaissance gravity and magnetic surveys, and continuous seismic profiling surveys can be run concurrently with the bathymetric and routine oceanographic surveys. Gravity, magnetic, and seismic maps of the shelves and slopes at 1:250,000 scale should be completed in about 15

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[1] Because of their special nature, oil and gas are treated in a separate section.

to 20 years. Cost of the total program is estimated at $225 to $250 million. The bathymetry, gravity, magnetic, and seismic mapping program should be closely correlated with the priority requirements of the geologic analysis program.

An understanding of the geologic structure and composition of the continental shelves and slopes is necessary to appraise the resource potential of this vast area. Such an understanding will also aid in determining favorable target areas for mineral resources, provide a basis for wise management of the offshore resources, enhance our understanding of geologic processes that form ore deposits, assist in the selection of safe sites for underwater installations, and help planners in making wise decisions involving multiple uses of the estuaries and shelves.

Recommendation:

A geological map and three-dimensional analysis of the continental shelves and slopes should be made at 1:250,000 reconnaissance scale. The mapping and analyses would use as bases the bathymetric maps and would utilize the gravity, magnetic, and seismic data from the surveys previously recommended; bottom sampling; examination of outcrops by submersibles and other means; and additional geophysical studies, such as aeromagnetic surveys and seismic profiling for deep structural information. In addition, acquisition of the necessary information for three-dimensional analysis will require drilling shallow holes (less than 500 feet deep) and approximately 100 deeper holes (500 to 5,000 feet) in undeveloped areas.

Studies at scales of 1:62,500 and larger will probably be needed in geologically critical areas. The total 1:250,000 scale reconnaissance program should be completed in 20 years. This program can best be carried out by a Government agency, but non-proprietary information available from private industry should be utilized to maximum extent. The geologic analysis program will require the control of ship facilities which preferably should be provided by other Government agencies so that the agency conducting the program would not have to acquire its own vessels.

Research on geologic and hydrologic processes that form and modify the earth's crust should be carried out in critical areas concurrently with the geologic mapping to develop new criteria to aid in the search for the resources both on land and beneath the sea.

The following areas should receive the highest priorities in the geologic analysis program:

–Offshore areas having highest potential for minerals.

–Areas of significant scientific importance (determined mainly by knowledge of the geology on land) that will enhance our understanding of the geologic history of the continental shelves and slopes and the origin and localization of mineral deposits.

–Coastal areas where population is rapidly expanding and where planning and management groups will need sound basic information in order to make judgments on the best use of marine areas.

Cost of the 20-year geologic analysis program is estimated in the following table:

1:250,000 Mapping Program of the
U.S. Continental Shelves

Total		**$423,000,000**
In-house		
2500 professional man years @ $60,000 (includes technicians)		**$150,000,000**
Equipment		**40,000,000**
Research Contracts		
University (includes ship time)		**125,000,000**
Industry Contracts		**108,000,000**
Ship time	**60,000,000**	
Aeromagnetics	**4,000,000**	
Submersibles	**5,000,000**	
Drilling of holes 500 to 5000 feet deep (100,000 ft.)	**10,000,000**	
Drilling of shallow core holes (less than 500 feet deep)	**9,000,000**	
Special sampling and geophysics	**20,000,000**	

B. Technology

It is a difficult and expensive task to prepare reasonably precise geologic maps in the marine environment. Unlike on land, suitable instruments and techniques are not available for determination of sea floor and subsurface geology, except by laborious and expensive methods. Present technology is inadequate to characterize either placer or nodule deposits on the seabed or *in situ* deposits that might be concealed in the rocks of the shelves and slopes. The latter deposits could constitute a major segment of our potential marine mineral resources.

Recommendation:[2]

An appropriate Government agency, working in cooperation with private industry, should develop tools, instruments, and techniques to improve seafloor and sub-seafloor geological surveys. Development of remote sensing equipment and subsea geophysical and geochemical techniques should have high priority. The Bureau of Mines should accelerate its effort to develop the tools and techniques to characterize marine ore bodies.

The deep ocean floors beyond the continental margins contain vast amounts of manganese nodules and red clays. Other valuable minerals not now suspected may lie either on or beneath the floors of the deep oceans.

Recommendation:

Bathymetric charting of the deep ocean floors beyond the continental slope and geologic and geophysical study of the deep ocean area together with appraisal of its resource potential should start in a modest way and build up to a funding amounting to about 25 per cent of the continental shelf and slope program within five years. The surveys should be at reconnaissance scale and the program of bathymetric, geophysical, and geological mapping should be closely coordinated. Priorities should be given to areas most likely to enhance knowledge of how mineral deposits are formed. Such areas would include the great fracture zones of the Pacific, the mid-Atlantic Ridge, and the Red Sea rift zone.

Present technology permits recovery of surficial deposits in nearshore areas by dredging, and exploitation of marine subsurface hard mineral resources by conventional underground mining methods to water depths of about 300 feet (except sulphur which can be extracted by drill hole extraction methods in slightly greater water depth). Significant quantities of mineral resources are known to lie well beyond this depth, and in fact beyond 200 meters. Deposits in the substrate of the continental shelves are possibly exploitable by lock tube in water depths as great as 300 feet, but significant resources may be present in shelf rocks well beyond this depth.

No equipment exists to exploit the phosphorite or manganese nodules in deeper waters. The present programs of mining corporations generally are limited to conceptual designs and small-scale engineering work pending future technological breakthrough in ocean engineering.

Recommendation:[3]

Development of the basic technology which must precede the development of operational mining equipment should be a function of Government in cooperation with industry.

Government and industry should work in close cooperation to develop marine sampling systems and improved delineation techniques and equipment, but the actual delineation of mineral deposits should be carried out by private industry.

A Government agency should have the function of testing the tools and equipment developed mainly by private industry, developing measurement instrumentation used in mining research and development, and setting standards for the mining industry.

This agency should be the source of information on the results of experience of industry and other Government agencies with underwater equipment and materials. It should serve as a medium for evaluating classified marine data and it should determine with the Department of Defense how critical information relating to underwater technology can best be made available to industry.

Ocean mining equipment and installations should be capable of functioning uninterruptedly and of enduring years of adverse sea conditions. This requires not only durability in the face of tremendous extremes of weather and sea conditions but also resistance to the powerful corrosive forces of sea water and organisms. The resistance to sea water corrosion of materials from which tools and machinery might be built is not well known.

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[2] Estimated costs covered by this recommendation for a 10-year level of effort are $50 million.

[3] Estimated costs covered by this recommendation for a 10-year effort are $130 million.

Recommendation:

A more comprehensive program for materials testing, data reporting, and interpretation of test data should be organized. An advisory board of marine materials authorities from industry, universities, private institutions, and Government should be established to guide the programs of the various agencies for materials testing.

It is a common assumption that dredging or other types of seafloor mining may be a major source of pollution and that mining will be generally incompatible with other resources and uses of the marine environment. However, no definitive study of this problem has been made. Meaningful economic evaluations of offshore hard mineral resources will probably be impossible in the absence of reliable information on the amount and kinds of pollution that may result from the extraction of mineral resources.

Recommendation:

A comprehensive study should be made to determine the amount and kinds of pollution that may result from seafloor mining operations and the potential effects of such pollution on the living resources and on the overall quality of the marine environment in the area where mining is done. Such a study should also determine what beneficial effects other than mineral production might result from sub-sea mining.

C. Legal/Regulatory

Fundamental differences exist in the philosophy, techniques, and costs of exploring for and exploiting oil and gas and exploring for and exploiting hard minerals.

The oil industry was easily attracted into the marine environment because the geology controlling the distribution of reservoirs commonly extends in uninterrupted sequence offshore. The same technology used on land, with modifications, was available to develop oil in progressively deeper waters. In the case of hard mineral deposits, only a few types of placers and bedded deposits like coal extend from onshore to offshore and the projection of favorable target areas is much more difficult. The oil industry has had long experience in evaluating concealed targets and because of the highly efficient geophysical and geological techniques used in the exploration for oil and gas reservoirs, the ratio of discovery holes to total exploration holes is high.

In contrast, the mining industry has only recently attacked the problem of concealed targets because most of the rich ore deposits that have sustained the Nation's needs were exposed on land at the surface and discovered by surface prospecting.

The technology and techniques for discovering concealed deposits, even on land, are still primitive and inefficient. The ratio of discoveries to targets explored is very low compared with oil and gas.

Virtually a whole new technology to search for offshore sub-bottom lode and bedded deposits will have to be devised. Offshore placer and nodule deposits will be somewhat easier to explore for than concealed bedrock deposits but will still pose considerable difficulties. A great many samples must be taken to define a placer deposit, and often the best material lies in cracks and depressions in the bedrock surface at the base of the unconsolidated material where it is difficult or impossible to reach.

Exploration costs are high for all concealed targets whether they be oil, gas, or mineral, but once an oil target has been located the discovery hole can be easily converted into a producing unit and extraction and operating costs are not excessive. In contrast, a discovery hole in a hard mineral deposit cannot quickly be converted into a production unit. Instead, the rate of exploration and development expenditure increases after discovery. The aggregate capital invested builds up substantially without any compensating revenue, usually over a period of several years.

Most important mineral commodities are products for world trade, and the market price is set over the years by those producers who can supply the demand at the lowest possible cost. Mineral developers must evaluate any exploration venture in the light of this world picture. They must eliminate prospects with the lowest geologic potential or poorest indicated financial return and concentrate on the most profitable.

Our continental shelf will be explored by private industry only if it appears that ore deposits which might be present there can be discovered and extracted more profitably there than elsewhere. Favorable land and ocean mining laws of other countries put them in direct competition with U.S. offshore exploration dollars. If the United States wishes to develop—or even test the likely extent of its offshore hard mineral resources—it will have to entice private industry exploration dollars from other kinds of exploration, in the United States and abroad on land and on the shelves of other countries.

It appears that the regulations governing offshore exploration and recovery of oil and gas are not an incentive for hard minerals development. A legal framework which encourages continental shelf exploration and mining by establishing an attractive investment opportunity for industry would be in the public interest.

At the present time it is extremely difficult to anticipate how the offshore mining industry may develop or what kind of properties and mining procedures are likely to be attractive. The Commission has a responsibility for assuring that inappropriate laws do not smother a nascent industry. A system for assigning mineral exploration and development rights on the Continental Shelf should:

—Be sufficiently flexible to recognize the great diversity in knowledge, resource potentials, technology and the physical characteristics of mining operations.

—Rely on competition to the extent feasible. However, companies should not be exposed to any international uncertainty as to the prospect of being able to exploit mineral deposits which they have discovered through privately-financed exploration.

—Provide a reasonable economic rent to the public for the use of public lands and public data.

—Recognize that the U.S. Government, as lessor of outer continental shelf lands, faces competition from other nations who may offer development rights to their offshore and onshore lands on terms calculated to attract mining enterprises.

Recommendation:

The Outer Continental Shelf Lands Act should be amended to allow the Department of the Interior greater flexibility in the management of offshore lands. The specific terms under which these lands are yielded to private development could be adjusted to reflect differences from case to case and over time in our knowledge of and capability to exploit mineral potentials. The amended legislation should establish the following options for exploring and for yielding exploration and minerals development rights on the Continental Shelf as defined in the Geneva Convention on the Continental Shelf, or, if recommendations of the International Panel are adopted, only to the 200 meter isobath or a distance of 50 miles, whichever is greater.

Where a promising minerals development opportunity has been identified by the Government or by Government-supported scientific institutions, bidding procedures should be used.

Where knowledge of mineral potential is too limited to permit successful bidding, and a company has expressed interest in exploration and/or exploitation, the Government should either contract to develop the data necessary to permit a competition for development rights, or announce in the Federal Register the applicant company's intent—absent objections—to explore the described area under a concession system which would also yield to it rights to develop any minerals which might be found.

Should any other company, within a specified time, indicate that it also has an interest in the exploration and possible development of the tract, the Department should conduct a competition among the interested companies for exploration and development rights.

Regardless of whether awarded as a result of bidding or negotiation, the rental and royalty terms which would apply under the permit should be specified before the permit would be granted or exploration begun.

A legal system somewhat analogous to the concession system practiced successfully in some foreign countries tentatively appears to be more appropriate to minerals development. The main provisions of such a system would include:

–A mineral explorer could obtain a permit for exclusive rights to explore a large area–say 100 square miles–on application. A large area under permit is essential in the beginning because any type of an anomaly would likely encompass a large search area. All minerals except oil, gas, and sulphur would be included.

–The permittee would be required to pay at least a nominal rental of $50 to $100 per square mile per year for the area held. Main purpose of the rental fee would be to discourage speculative holdings.

–Permittee would be required to do a minimum amount of work each year and would be required to turn back half the original area at the end of the first year, half the remaining area at the end of the second year, and so on. The minimum work obligation would increase on a sliding scale each year. The permittee would have the option of turning back the entire remaining parcel at any time.

–In the event of a mineral discovery, the permittee could convert all or any portion of the remaining permit area into a lease to exploit without competitive bidding. The lessee would have the right to extract any of all minerals present except oil, gas, or sulphur.

–Lessee would be required to pay rental on the land and royalty on the gross value of minerals produced at the lease. Royalty and lease term would be negotiated.

–Upon expiration of the lease term renewal could be applied for if the deposit showed promise of future production. Otherwise the property would revert to the Government.

Offshore mining is most likely to start in shallow water near the shore in areas under State jurisdiction, and extend into deeper water as technology advances. A deterrent to nearshore exploration and mining is that the regulations of various States relative to offshore mining, where they exist, differ significantly. Some coastal States apparently do not have provisions for issuing offshore exploration permits.

A National Conference of Coastal States was called to meet on Dec. 11-13, 1968, in Portland, Oregon. Representatives of a number of industries interested in coastal waters also participated in the conference. The purpose of the conference was to develop specific guidelines on hard mineral mining from submerged lands under state control. The results of the conference were unavailable as this report went to press. However, it is hoped that the conference considered and recommended action on the problem of providing a permit system that would clarify and safeguard the mineral explorer's rights in areas under State jurisdiction. If the action discussed above was not taken, the panel makes the following recommendation:

Recommendation:

The Department of the Interior, in concert with representatives of the mining industry, should develop a model system for assigning minerals exploration and development rights along the lines recommended above, for consideration by the States. The appropriate Federal agency should sponsor a convention of coastal States to consider the model and other legal and economic problems of offshore mining.

Sulphur and other types of hard minerals may occur in the continental slopes as well as in the shelves. The slopes between the 200 and 2500 meter contours around the United States include about 479,000 square statute miles. Under the existing international regime the mineral exploiter's rights are not clearly protected in the area seaward of the 200 meter isobath, and this may eventually be a deterrent to offshore mineral exploitation.

Recommendation:

An international legal regime is needed that will provide protection for the mineral exploiter in waters seaward of the 200 meter isobath. A regime that the panel believes to be satisfactory is described in detail in the report of the International Panel.

The location of our boundaries with adjacent nations on the continental shelves and slopes has not been defined. Lack of definition of these boundaries will eventually lead to dispute when marine mining becomes feasible.

Recommendation:

The Federal Government should take the necessary steps as soon as possible to determine its offshore boundaries with adjacent nations.

D. Education

In the absence of firm estimates as to the degree of offshore mineral exploration and exploitation in future years, some idea of the educational requisites may be gained by a projection based on an assumption of activity. In 1965, U.S. offshore hard mineral production, including minerals extracted from sea water, was equal to 1.5 per cent of onshore production. If it is assumed that offshore production in 1985 will be 5 to 10 per cent of onshore production, the numbers of newly trained professionals and technicians will be:

Engineers	2,050– 4,100
Technicians, all types	7,800–15,600
Marine geoscientists[4]	850

I. INTRODUCTION

Minerals are the raw materials of which most things we use are made. Structures, roads, communication networks, and machines are built largely of mineral products. Agricultural output is sustained with the aid of mineral fertilizers and insecticides and by the use of machines. An adequate, dependable, and continuing supply of minerals is required to maintain the industrial strength and security of the United States. The demands of an increasing population and rising standard of living, coupled with the instability inherent in a constantly changing international situation, make the mineral supply outlook a major National concern.

During the last 30 years the United States has used more minerals and fuels than the entire world in all previous history. And the demand for many minerals will nearly double by 1985 and perhaps triple by the year 2000. Competition for the world's mineral resources will become more severe as industrialization of the developing countries progresses and as more and more people attain the means to realize the higher living standards they desire. In order to assure that the Nation will have an adequate and dependable supply of mineral materials in the face of this competition it will be necessary to diversify our resource base and to increase our rate of discovery from new sources.

Mineral resources are exhaustible and nonrenewable. They are a one-time crop, unlike living resources, which may continue to be available indefinitely under proper husbandry. The United States, which had furnished about two-thirds of the world's mineral wealth during the period 1850-1900 and consumed half of this wealth, was first made aware that mineral depletion is an irreversible process during World War I and the lesson was brought home even more forcibly during World War II. As a result of the demands originating with World War II new sources of iron ore were sought in Canada and South America; new sources of bauxite for aluminum were developed in Sumatra, Jamaica, Panama, Costa Rica, and West Africa; and new mines were developed in various foreign countries for all the basic industrial minerals including copper, zinc, lead, iron, sulphur, etc.

Of 72 strategic and critical commodities indispensable to our economy in time of conventional warfare, more than 40 are largely imported from foreign countries. Notable deficiencies are in certain ferroalloy minerals and in some of the strategic nonmetallic minerals.

Although minerals as mined are nonreproducible and as such represent a wasting resource, there are nevertheless the possibilities of new mineral discoveries and the potential inherent in an advancing technology to assure the replenishment of depleted reserves. The ore reserves for many metals have been sustained by improved technology that has made it profitable to mine material of lower and lower grade. Copper is a well known example. In the 1860's and 1870's the ores mined in the western United States contained upwards of three per cent copper; at the beginning of World War I it was about two per cent; and at present many ores mined contain less than one per cent. Volume production techniques such as open pit mining, flotation recovery, and other methods have made the mining and processing of such lean ores feasible. It is possible that copper ores in the future can be mined profitably down to a fraction of the present grade.

Reclamation is also an important factor in extending the supply of some minerals. For example, although the gasoline powering an automobile and the lead added to it are consumed beyond reclamation, about 85 per cent of the lead that makes up much of the same automobile's battery can be reclaimed. Substantial amounts of zinc, copper, aluminum, and other metals are also reclaimable.

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[4] Figure for marine geoscientists is that required to make three-dimensional geological analysis of the continental margins.

A. Demand and Adequacy from Conventional Sources

Can the United States between now and the year 2000 obtain all the minerals and mineral products it needs? Can it obtain them at no significant increase in relative cost? Are there any specific minerals or groups of minerals for which supply is apt to become critical or an absolute shortage develop? What substitute materials might be used? And what are the prospects for supply from marine sources?

To attempt to answer these questions makes it necessary to project possible demands for minerals over the remaining years of this century. A projection is a determination of what the future source of some statistical measure such as average family income or average copper consumption would be under a certain set of starting assumptions.[5] Projections are never predictions of what is actually going to happen but if skillfully made they can show implications of present trends and programs, and provide a benchmark for appraising later events as they actually occur.

In Appendix A demand figures are projected to the years 1970, 1985, and 2000 for 26 mineral commodities that, based on existing knowledge, we have some hope of finding in the marine environment. The demand figures were prepared by mineral commodity specialists of the Bureau of Mines and the projections are based on historical consumption data for the period 1947-1966. The projected demands to 1985 and 2000 are summarized in Figures 1 and 2.

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[5] Hans Landsberg, *Natural Resources for U.S. Growth* (Baltimore: Johns Hopkins Press, 1964), p. 6.

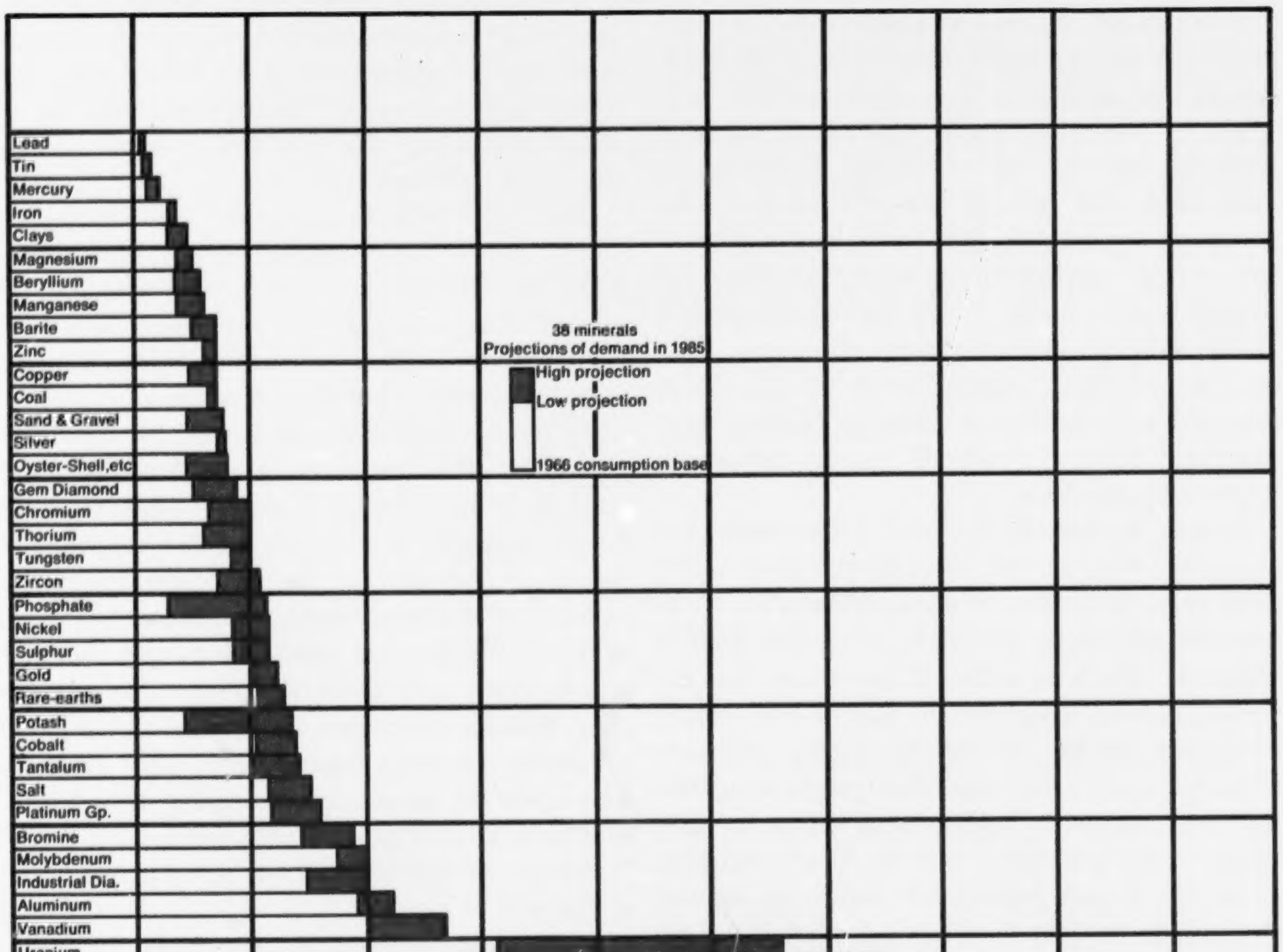

Figure 1. *38 minerals–projections of demand in 1985.*

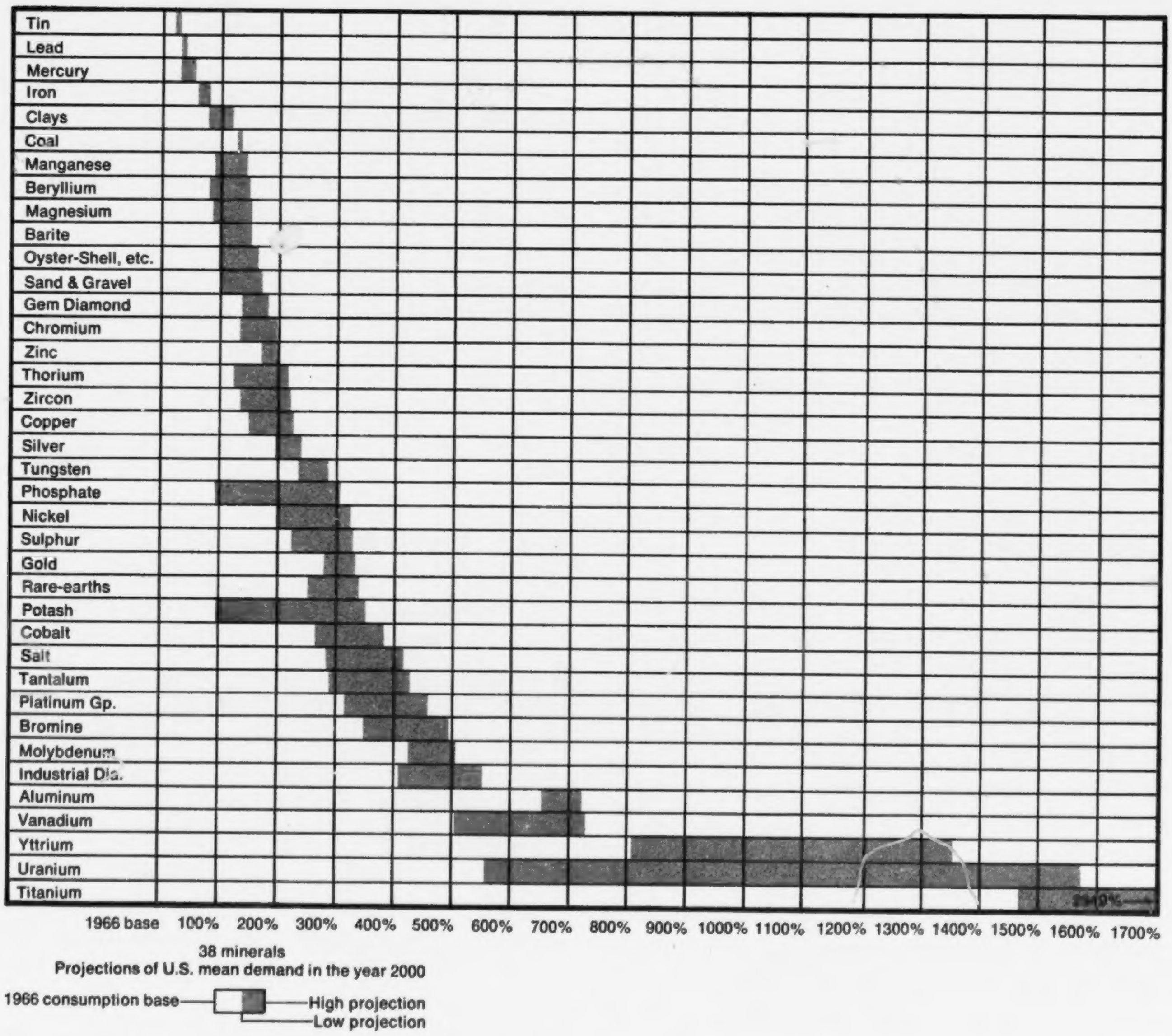

Figure 2. *38 minerals–projections of U.S. mean demand in the year 2000.*

Simple least square regression curves are best fit (assuming significance) by computer to base projection curves (independent variables) such as Federal Reserve Board Index, Gross National Product, Steel Production, Population, Time, Gross Private Business Investment, and Gross Private Domestic Investment. Obviously, uncertainties multiply with each passing decade, so that the more distant projections are less reliable than those of the near term. Basic assumptions which underlie all the projections are continuing gains in technology, improvements in political and social arrangements, and a reasonably free flow of world trade. It is also assumed that there will be neither a large-scale war nor another depression.

As Figures 1 and 2 show, the projected rise in demand for different minerals over the next 30-plus years will be uneven. For new supplies of lead and tin the mean increase in demand over 1966 levels is only 8 and 11 per cent, respectively, to 1985, and 34 and 22 per cent respectively to the year 2000. On the other hand, the projected mean increase in demand for industrial diamonds is 175 per cent to 1985 and 475 per cent to 2000, while the projected demand for titanium is an astonishing 661 per cent to 1985 and 2184 per cent to 2000. However, it should be noted that the projection for titanium starts from a very small base.

Are supplies of minerals available to the United States from conventional land sources without a significant increase in price adequate to meet the projected demands? The answer is an unqualified yes for some mineral commodities, including iron, coal, magnesium, bromine, lithium, phosphate, potassium, sodium, and vanadium, and perhaps for copper, molybdenum, and sulphur.

However, for other mineral commodities such as chromium, manganese, nickel, cobalt, industrial diamonds, platinum, and tin we are almost totally dependent on foreign sources of supply and hence have no control on prices. Many of these minerals come from politically unstable areas, a constant threat to the Nation's source of supply. A third group including aluminum, lead, zinc, and tungsten, among others, is in the borderline category. Sufficient new domestic deposits could come into production to fill our needs without a significant rise in price but this will depend on technological advances and new discoveries.

An appraisal of cumulative U.S. demand versus U.S. reserves and resources[6] for about 30 key mineral commodities is shown in Table 1.

As may be deduced from the descriptions of individual mineral commodities (Appendix A), substitute materials may be used for many of them, such as aluminum for copper, nickel for chromium, etc. However, in many instances the substitute materials are themselves in relatively short supply, so that substitution in most cases provides only a partial or temporary answer to the problem. The fact remains that new sources of supply for many mineral commodities will be needed to meet the projected demands and insure the security and economic viability of the United States. Many—probably most—new sources will derive from new discoveries on land and from technological advances that will permit the economical exploitation of lower grade deposits. Another potential source of supply is the sea.

B. Potential from Marine Sources[7]

The world's oceans are the storehouse of a wide array of mineral materials[8] with greatly varying characteristics and occurrences, including those dissolved in the sea water, those accumulated on the ocean floor, and those locked in the rocks beneath the ocean floor. At present common salt, magnesium, bromine, and fresh water are being recovered from sea water and their total annual value, worldwide, is estimated to be $385 million,[9] of which the United States accounted for $117 million in 1966 (Table 2).

In recent years iron, coal, sulphur, tin, diamonds, gold, shells, ilmenite, rutile, zircon, monazite, and sand and gravel have been mined in several marine areas of the world and their total annual production is now valued at $534 million. The United States accounted for $49.2 million in 1966. All these operations are largely confined to the shallow water portions of continental shelves. Current technology and economics do not presently permit the extraction of minerals (except oil, gas, and sulphur) from beyond the shallower parts of the shelves, but given advances in ocean mining and processing technology mining of certain minerals in deeper parts of the ocean may become economically feasible in the future.

The U.S. Continental Shelf to a depth of 200 meters includes about 850,000 square miles. The continental slope from 200 meters to a depth of 2500 meters has an area of about 479,000 square miles.[10] The 2,500 meter isobath is considered by

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[6] Two terms that need definition are "resources" and "reserves." Resources is the broader term and applies to materials in the ground that may or may not be minable at present but which may come into such demand as to become minable in the future. "Reserves" are materials that may or may not be completely explored but may be quantitatively estimated and are considered to be economically exploitable at the time of the estimate. Reserves fluctuate because they depend on economic conditions, technologic factors and available information. A low-reserve figure does not necessarily mean that the resource is near exhaustion. It may mean that exploration is lacking or that a depressed market has lowered the value of the commodity to the point where the material can no longer be considered economically exploitable.

[7] A paradox that arises in this report and of which the reader should be forewarned is that whereas the sheer size of our continental shelves and slopes (more than 1.3 million square miles) lends itself to optimistic inference regarding its mineral potential, the appraisal of the potential for individual mineral commodities in Appendix A is largely negative. This incongruity stems largely from lack of knowledge, and the gap between the two estimates will be narrowed as the program recommended herein progresses and knowledge is gained.

[8] John V. Bryne, "The Oceans: A Neglected Mining Frontier," Oregon Dept. of Geology and Mineral Industries, *The Ore Bin*, Vol. 26, pp. 57-69, 1964; H. D. Hess, "The Oceans: Mining's Newest Frontier," *Engineering and Mining Journal*, Vol. 166, p. 91, August 1965; John L. Mero, *The Mineral Resources of the Sea* (New York: Elsevier, 1965).

[9] W. F. McIlhenny, "Chemicals from Sea Water," in *Proceedings of the Inter-American Conference on Materials Technology*, May 1968, p. 119.

[10] V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

Table 1

U.S. AND WORLD LAND RESERVES AND RESOURCES OF SOME METALS AND NONMETALS THAT MAY OCCUR IN THE CONTINENTAL SHELVES

	Minable Reserves[1]		Resources[2]		Projected Cumulative Demand, 1966 to 2000 (rounded from Bureau of Mines estimates)	
Commodity	United States	World (including U.S.)	United States	World (including U.S.)	United States	World (including U.S.)
Aluminum (bauxite, millions, long tons)	45	5,800	300	9,600	440[4]	840
Barite (millions, short tons)	60	130	100	[3]	80	190
Beryllium (short tons, equiv. beryl)	[3]	[3]	1,000,000	1,650,000	360,000	540,000
Bromine (million pounds)	Vast	Vast	Vast	Vast	22,000	30,000
Borates (millions, short tons B_2O_3)	95	110	[3]	[3]	4	14
Chromium (millions, long tons, chromite)	0	2,000	8	Several billion	22	74
Copper (millions, short tons)	86	210	65	[3]	140[4]	400
Cobalt (thousands, short tons)	50	2,200	[3]	[3]	600	1,300
Gold (millions, troy ounces)	50	1,000	400	[3]	670	2,370
Helium (billions, cubic feet)	154	[3]	42	[3]	60	[3]
Industrial diamonds (million carats)	0	[3]	0	[3]	1,700	3,600
Iron ore (millions, long tons)	8,000	250,000	100,000	250,000	6,400	35,000
Lead (millions, short tons)	35	83	15	[3]	57	180
Manganese ore (millions, long tons)	0	3,800	1,000	15,000	50	450
Mercury (thousands of flasks)	200	7,000	500	10,000	3,600[4]	11,400
Nickel (thousands, short tons)	250	60,000	1,400	[3]	14,500[4]	31,700
Niobium (thousands, short tons, Nb_2O_5)	125	9,800	165	8,600	190	370
Phosphate (millions, long tons)	12,000	48,000	48,000	[3]	500	2,000
Potash, (millions, short tons, K_2O)	1,400	72,000	5,000	Very large	300	1,100
Platinum Group (millions, troy ounces)	3	280	[3]	[3]	144[4]	250
Rare Earths (millions, short tons, Re_2O_3)	5	[3]	[3]	5	.5	1
Salt (trillions, short tons)	60	Vast	[3]	[3]	.003	.009
Silver (millions, troy ounces)	1,400	5,500	500	[3]	14,000[4]	31,000
Sulfur (millions, short tons)	[3]	[3]	500	2,000	690	2,600
Tantalum (short tons, Ta_2O_5)	2,100	170,000	[3]	95,000	54,000	104,000
Tin (thousands, long tons)	9	5,600	43	11,400	3,200[4]	9,200
Titanium (millions, short tons, TiO_2)	100	500	[3]	Vast	50	100
Thorium (thousands, short tons, Tho_2)	0	82	200	1,000	5	15
Tungsten (thousands, short tons)	70	1,500	200	[3]	620	2,040
Uranium (thousands, short tons, U_3O_8)	210	742	675	2,700	1,500	3,750
Vanadium (thousands, short tons)	200	3,500	1,300	20,000	650	1,000
Zinc (millions, short tons)	29	100	60	[3]	90	280
Zircon (millions, short tons)	6	30	[3]	[3]	3.0	10

Source: Compiled by Geological Survey commodity geologists.

[1] Minable reserves are materials that may or may not be completely explored but that may be quantitatively estimated and are considered to be economically exploitable at the time of the estimate.

[2] Resources are materials other than reserves that are prospectively usable and include undiscovered recoverable resources as well as those whose exploitation requires more favorable economic or technologic conditions.

[3] Unknown.

[4] Demand figures include a significant quantity of recycled metal.

Table 2
VALUE OF MINERAL PRODUCTION FROM OCEANS BORDERING THE UNITED STATES
1960-67
(millions of dollars)

Commodity	1960	1961	1962	1963	1964	1965	1966	1967
From sea water:								
Magnesium metal and compounds, salt, and bromine	$ 69.0	$ 73.0	$ 89.1	$ 84.6	$ 94.5	$102.6	$117.0	$145.4
From ocean subfloors:								
Petroleum, natural gas, and sulphur	423.6	496.6	620.7	730.8	820.3	933.3	1,177.7	1,404.8
From beaches and in-shore sea floors:								
Sand and gravel, zircon, feldspar, cement rock, and limestone	46.8	46.2	44.3	42.5	43.6	51.4	51.6	55.9
Total	539.4	615.8	754.1	857.9	958.4	1,087.3	1,346.3	1,606.1

Source: Bureau of Mines.

the Geological Survey to form the approximate boundary of continental-type rocks and therefore the geologic boundary of the continental block. The U.S. continental shelves and slopes include about 1.3 million square miles, or an area about 35 per cent as large as the land area.

The resource potential of the shelves and perhaps the slopes should be roughly comparable to that of the equivalent land area. Around the entire U.S. coastline, a belt the width and area of the Continental Shelf landward of the shoreline has produced about $160 billion of hard minerals and $75 billion of oil and gas in 1966 dollars.[11] And since mineral production is still growing in the United States so it is not possible to predict the ultimate value of minerals from this onshore belt. The production to be expected from offshore surely will be less than from an equivalent area on land because of the much greater difficulty and expense required to find and exploit the resources. Nevertheless, the offshore plainly offers good opportunities for increased production.

Marine mineral resources can be divided into four, or possibly six, main types, based on the specific environment in which they occur. The basic types are:

–Chemical constituents of sea water;

–Submerged placer deposits and other surficial deposits (sands and gravels) that occur as patches of unconsolidated material on and immediately beneath the continental shelf (although not of placer origin, oyster shell and lime mud may be included in this group);

–Deposits locked in the substrate rocks of the continental shelves and slopes;

–Deposits on the abyssal plains of the deep ocean basins.

–A fifth potential type, analogous to the third type, is that which may occur in the substrate of the deep ocean basins.

–A sixth potential type embraces metal-rich hot brines and mud such as occur in the Red Sea and the Atlantic Deep.

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[11] Bureau of Mines.

Table 3
SUMMARY TABLE SHOWING POTENTIAL OF HARD MINERAL COMMODITIES FROM U.S. MARINE SOURCES (INCLUDING WATER COLUMN AND CONTINENTAL SHELVES AND SLOPES) [1]

Currently produced	Good potential	Fair to poor potential
Bromine	Gold Phosphate	Barite
Magnesium and magnesium salts	Monazite (thorium and rare-earths)	Chromite (and chrominum)
Oyster shell and calcium carbonate mud	Staurolite	Iron
Salt	Kyanite and sillimanite	Lead
		Mercury
Sand and Gravel	Titanium minerals	Platinum
Sulphur	Zircon	Silver
		Tin
		Manganese
		Nickel
		Cobalt
		Copper
		Molybdenum
		Uranium
		Vanadium
		Coal

[1] From deep sea floor the potential for manganese, cobalt, copper, and nickel from manganese nodules is rated fair to good.

1. Chemical Constituents of Sea Water

The mineral resources presently derived from sea water–salt, magnesium, and bromine–are present in sufficient concentration in the sea as to be inexhaustible, and their production is limited only by demand and by plant capacity.

Table 4 lists data on the concentrations and amounts of 22 elements and compounds in sea water.

The data show that the lithosphere's average content of these common elements vastly exceeds that of the sea for all the elements except sulphur. The extremely low concentration of elements in sea water is a major deterrent to commercial production of minerals now obtained from rocks. For example, the average yield of copper ores mined today is 15,000 parts per million whereas the sea contains only 0.003 part per million, one 5 millionth that of the lithosphere. The gross value per cubic mile of sea water of 17 common industrial elements, in most of which there is a national shortage, is slightly less than $600,000.[12] A plant to recover these 17 elements would have to be about the size of the present Dow magnesium plant at Freeport, Texas which pumps about two million gallons per minute or about one cubic mile per year. It is not economically feasible to build and operate a plant of this size to recover 17 elements having a yearly gross value of only $600,000. Important technological advances must be made before elements other than those presently being recovered can be profitably extracted from sea water.

2. Submerged Placer Deposits

The nature of submarine placer deposits is described by Emery [13] as follows:

Placer deposits are formed where streams or waves and currents cause heavy minerals to be selectively deposited in isolation from relatively worthless

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[12] Calculated by C. M. Shigley, Dow Chemical Company. The elements included are antimony, bismuth, cadmium, chromium, cobalt, copper, gold, lead, manganese, mercury, molybdenum, nickel, silver, tin, titanium, uranium, and zinc.

[13] K. O. Emery, "Geological Methods for Locating Mineral Deposits on the Ocean Floor," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966), p. 27.

Table 4
AVERAGE AND TOTAL CONTENTS OF SELECTED MINERAL RAW MATERIALS IN ALL SEA WATER AND IN A THREE-KILOMETER CRUST OF THE LITHOSPHERE

Elements	Average Content—Parts Per Million		Total Content[1] Billion (10^9) Metric Tons		Ratio: Total Content Seawater to Lithosphere, One to:
	Seawater	Lithosphere	Seawater	Lithosphere	
Common Metals					
Aluminum	0.01	81,300	14.2	100,812,000	7,100,000
Iron	0.01	50,000	14.2	62,000,000	4,400,000
Manganese	0.002	1,000	2.84	1,240,000	440,000
Chromium	0.00005	200	0.071	248,000	3,500,000
Zinc	0.01	132	14.2	164,000	11,600
Nickel	0.002	80	2.84	99,000	35,000
Copper	0.003	70	4.26	87,000	20,000
Tin	0.003	40	4.26	50,000	11,700
Lead	0.0001	16	0.142	19,800	139,000
Gold	0.000004	0.001	0.00548	1.24	218
Silver	0.0003	0.10	0.426	124	291
Space Age Metals					
Titanium	0.001	4,400	1.42	5,456,000	3,840,000
Zirconium	–	220	–	273,000	–
Tungsten	0.0001	50	0.142	62,000	440,000
Columbium	0.00001	24	0.0142	29,800	2,100,000
Cobalt	0.0005	23	0.71	28,500	40,000
Beryllium	0.0000006	6	0.000852	7,400	8,700,000
Uranium	0.003	4	4.26	5,000	1,170
Molybdenum	0.01	3	14.2	3,700	260
Fertilizer Elements					
Potassium	380.0	25,900	539,600.0	32,116,000	59
Phosphorus	0.07	1,180	99.4	1,463,000	14,800
Sulfur	885.0	520	1,256,700.0	645,000	0.5

Source: Ocean Engineering, Vol. 4, Pt. 1, 1966. Sea water: E.D. Goldberg, "Marine Geochemistry," *Annual Review of Physical Chemistry*, pp. 29-48; 1961 lithosphere: K. Rankama and Th. G. Sahama, *Geochemistry* (Chicago: University of Chicago Press, 1950).

[1] Based on following masses: oceans: 1.42 x 10^{18} metric tons; lithosphere crust: 1.24 x 10^{18} metric tons.

lighter minerals that are carried away. The minerals must previously have undergone extensive weathering and erosion from their original position within igneous and metamorphic rocks. Because the ocean floor lacked sufficient weathering and erosion few if any placer deposits should have originated on it. Instead, placers on the ocean floor should be extensions of well-known ones on land–such as the gold of Alaska, the tin of Malaya and Cornwall, and the diamonds of Southwest Africa. Placers are unrelated to the composition of their substrate, but they occur only near their primary igneous or metamorphic source rocks.

Most of the placers of submerged beach and drowned river valley types were formed during the Ice Ages when sea level was lowered as much as 137 to 160 meters below the present sea level[14] because so much ocean water was in the form of ice in continental glaciers. Owing to the cyclic nature of the Ice Ages and the intervening warm interglacial periods, a series of beaches and extensions of stream channels were formed in some

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[14] W. L. Donn, W. R. Farrard, and M. Ewing, "Pleistocene Ice Volumes and Sea Level Lowering," *Journal of Geology*, Vol. 70, No. 2, 1962, pp. 206-214.

Table 5
OFFSHORE MINING OPERATIONS IN 1967
UNCONSOLIDATED DEPOSITS

Mineral	Location	Number of Operations	Annual Production	Year	Value ($ million)
Diamonds	S. W. Africa	1	221,500 Yds^3	1964-65	8.9
Gold	Alaska	1	–	1966	–
Heavy mineral sands	America Europe S.E. Asia Australia	15	1,307,000 tons	1965	13.1
Iron sands	Japan	3	36,000 tons	1962	3.6
Tin sands	S.E. Asia, U.K.	4	10,000 tons concentrate	1965	24.2
Lime shells	U.S.A. Iceland	9	20,000,000 Yds^3	1965	30.0
Sand and gravel	U.K. U.S.A.	38	100,000,000 Yds^3	1966	100.0
Total		71			$179.8

Source: Charles M. Romanowitz, Michael J. Cruickshank, and Milton P. Overall, "Offshore Mining Present and Future," presented at NSIA/OSTAC Ocean Resources Subcommittee Meeting, San Francisco area, April 26, 1967.

areas at various depth levels anywhere from the present 160-meter line to a little above the present shoreline. With the post-glacial rise of sea level that accompanied the melting of the glaciers, the ancient beaches and river channels, which in places contain valuable placers, were submerged and may have been buried by still younger sediments. In some shallow water areas, however, there are offshore placers related to bottom topography and offshore currents rather than to beach or alluvial processes.

Nevertheless, the placers in the marine environment are mainly confined to the inner edge of the continental shelves, and it is unlikely that significant placer deposits will be found on the continental slope or beyond.

Several good prospects for the development of placers exist on the shelves of both the east and west coasts of the United States. None is now in production and all are low grade, but they have sufficient potential value to warrant further prospecting and improvement of mining technology. In general, the composition of mineral assemblages of east coast placers differs from that of west coast placers although there is some overlap. The following tabulation from Overstreet[15] is indicative of the valuable minerals that might be expected in the two regions:

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[15] In McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

West coast placer minerals	*East coast placer minerals*
Gold	Ilmenite
Platinum	Rutile
Cassiterite	Monazite
Magnetite	Xenotime
Ilmenite	Zircon
Chromite	Kyanite
Zircon	Sillimanite
Rutile	Staurolite

Not all of the west coast placer minerals are likely to be found in individual deposits. In the history of west coast placer mining only gold, platinum, and minor amounts of tin have been recovered in commercial operations. Off the coast of Alaska there may exist minable resources amounting to millions of ounces of gold, hundreds of thousands of ounces of platinum, and thousands of tons of tin. Minable deposits of gold and platinum may be present off the coasts of Oregon and California. Ilmenite is the sole product from some east coast placers, but others contain as potential products all those listed above.

Deposits of marine phosphorite[16] nodules are found on continental shelves and the upper parts of slopes, as well as on submarine banks and ridges. Although the nodules in places have been washed by bottom currents and perhaps concentrated to some extent as silt and clay were winnowed away, they are not of detrital origin like the placers but are derived from erosion of Tertiary phosphatic beds exposed on the sea floor or precipitated from sea water, forming in areas of cold upwelling, nutrient-rich waters.[17]

3. Deposits in the Substrate of Shelves and Slopes

The principle resources locked in the substrate rocks of the continental shelves and slopes are oil, gas, and sulphur. However, other potentially important resources in this environment include coal, bedded salt that may contain potash-rich layers, phosphatic rock, iron ore, bauxite, beds rich in placer minerals, and possibly

Table 6
OFFSHORE MINING OPERATIONS IN 1967
CONSOLIDATED DEPOSITS

Mineral	Location	Number of Op's	Production Year	Year	Value (In millions)
Iron ore	Finland Newfoundland	2	1,700,000 tons	1965	17.0
Coal	Nova Scotia Taiwan Japan Turkey United Kingdom	57	33,500,000 tons	1965	335.0
Sulphur	USA	1	600,000[1]	1965	15.0
Total		60			$367.0

Source: Charles M. Romanowitz, Michael J. Cruickshank, and Milton P. Overall, "Offshore Mining Present and Future," presented at NSIA/OSTAC Ocean Resources Subcommittee meeting, San Francisco area, April 26, 1967.

[1] Estimated.

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[16] See Appendix A for fuller discussion of phosphorite.

[17] V. E. McKelvey and Livingston Chase, "Selecting Areas Favorable for Subsea Prospecting," in *Exploiting the Ocean,* (Washington, D.C.: Marine Technology Society, 1966) p. 46.

metallic vein deposits. Sulphur is being recovered from offshore salt domes in the Gulf of Mexico, and coal has been mined off the coasts of Canada, the United Kingdom, Japan, and Taiwan, either through inclined access tunnels driven from shore-based coal mines or from vertical shafts drilled through artificial islands constructed in the sea.[18] Iron ore deposits of commercial grade are known in the shelf area of the Gulf of Finland and off the coast of Newfoundland. Tin deposits probably extend into the shelf off the coast of Cornwall in the United Kingdom.

Metallic vein deposits are commonly associated with intrusive igneous rocks. Although the shelves and slopes are composed dominantly of sedimentary rocks, igneous rocks are known in three areas on the continental shelf of the United States: the Gulf of Maine, Monterey Bay, and off the Golden Gate in California.[19] Samples from these areas have not shown valuable mineralization. Nevertheless, onshore lode or bedrock deposits are sufficiently abundant nearshore in Alaska, the west coast states, and the New England states to suggest the possible presence of offshore deposits of similar character in rocks of the shelf.

It is evident from the foregoing pages and from the data in Appendix A that our knowledge of the hard mineral potential of our continental shelves and slopes is very slight. Bathymetric mapping and charting and geologic analysis are needed.

Bathymetric charts showing the contour of the sea floor are, like topographic maps on land, the base on which many other types of information are plotted. It is essential that good bathymetric charts be available if other information, such as distribution of geologic formations and structures and delineation of mineral deposits are to be analysed and interpreted in a meaningful way.

Recommendation:

Bathymetric charts at 1:250,000 scale should be completed for the entire U.S. continental shelves and slopes within 15 to 20 years by a Government agency (ESSA). Reconnaissance gravity and magnetic surveys, and continuous seismic profiling surveys can be run concurrently with the bathymetric and routine oceanographic surveys. Gravity, magnetic, and seismic maps of the shelves and slopes at 1:250,000 scale should be completed in about 15 to 20 years. Cost of the total program is estimated at $225 to $250 million. The bathymetry, gravity, magnetic, and seismic mapping program should be closely correlated with the priority requirements of the geologic analysis program.

An understanding of the geologic structure and composition of the continental shelves and slopes is necessary to appraise the resource potential of this vast area. Such an understanding will also aid in determining favorable target areas for mineral resources, provide a basis for wise management of the offshore resources, enhance our understanding of geologic processes that form ore deposits, assist in the selection of safe sites for underwater installations, and help planners in making wise decisions involving multiple uses of the estuaries and shelves.

Recommendation:

A geological map and three-dimensional analysis of the continental shelves and slopes should be made at 1:250,000 reconnaissance scale. The mapping and analyses would use as bases the bathymetric maps and would utilize the gravity, magnetic, and seismic data from the surveys previously recommended; bottom sampling; examinations of outcrops by submersibles and other means; and additional geophysical studies, such as aeromagnetic surveys and seismic profiling for deep structural information. In addition, acquisition of the necessary information for three-dimensional analysis will require drilling shallow holes (less than 50 feet deep) and approximately 100 deeper holes (500 to 5,000 feet) in undeveloped areas.

Studies at scales of 1:62,500 and larger will probably be needed in geologically critical areas. The total 1:250,000 scale reconnaissance program should be completed in 20 years. This program can best be carried out by a Government agency, but non-proprietary information available from private industry should be utilized to the fullest extent possible. The geologic analysis program will require the control of ship facilities which preferably should be provided by other Government agencies so that the agency conducting the program would not have to acquire its own vessels.

Research on geologic and hydrologic processes that form and modify the earth's crust should be

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[18] United Nations Economic and Social Council, *Resources of the Sea: Part 1, Mineral Resources Beyond the Continental Shelf*, report of the Secretary General, February 1968 (E4449/Add. 1).

[19] Emery.

carried out in critical areas concurrently with the geologic mapping to develop new criteria to aid in the search for resources both on land and beneath the sea.

The following areas should receive the highest priorities in the geologic analysis program.

–Offshore areas having highest potential for minerals.

–Areas of significant scientific importance (determined mainly by knowledge of the geology on land) that will enhance our understanding of the geologic history of the continental shelves and slopes and the origin and localization of mineral deposits.

–Coastal areas where population is rapidly expanding and where planning and management groups will need sound basic information in order to make judgments on the best use of marine areas.

Cost of the 20-year geologic analysis program is estimated in the following table:

1:250,000 Mapping Program of the U.S. Continental Shelves

Total		**$423,000,000**
In-house		
2500 professional man years @ $60,000 (includes technicians)		**$150,000,000**
Equipment		**40,000,000**
Research Contracts		
University (includes ship time)		**125,000,000**
Industry Contracts		**108,000,000**
Ship time	**60,000,000**	
Aeromagnetics	**4,000,000**	
Submersibles	**5,000,000**	
Drilling of holes 500 to 5000 feet deep (100,000 ft.)	**10,000,000**	
Drilling of shallow core holes (less than 500 feet deep)	**9,000,000**	
Special sampling and geophysics	**20,000,000**	

The technology for extracting large and rich mineral deposits from the substrate of the continental shelves to depths of possibly 300 feet or more is within the range of modern technology.[20] However, the science and exploration technology for identifying and evaluating such hidden deposits still needs to be developed.

It is a difficult and expensive task to prepare reasonably precise geologic maps in the marine environment. Unlike on land, suitable instruments and techniques are not available for determination of sea floor and subsurface geology, except by laborious and expensive methods. Present technology is inadequate to characterize either placer or nodule deposits on the seabed or *in situ* deposits that might be concealed in the rocks of the shelves and slopes. The latter deposits could constitute a major segment of our potential marine mineral resources.

Recommendation:[21]

An appropriate Government agency, working in cooperation with private industry, should develop tools, instruments, and techniques to improve seafloor and sub-seafloor geological surveys. Development of remote sensing equipment and subsea geophysical and geochemical techniques should have high priority. The Bureau of Mines should accelerate its effort to develop the tools and techniques to characterize marine ore bodies.

4. Deposits on the Deep Ocean Floors

The only presently known materials of potential economic importance on the deep ocean floors beyond the continental slopes are the manganese nodules and crusts. Surficial deposits of red clay, siliceous ooze, and calcareous ooze are extensive but are of little or no potential economic importance. Some of these materials, i.e., red clays and manganese nodules, apparently cover tens of millions of square miles of ocean bottom. Manganese nodules contain significant amounts of copper, cobalt, and nickel in addition to manganese unconsolidated placer deposits on beaches and the continental shelf; and bedrock deposits in the shelves. Current offshore mineral production on a worldwide basis (exclusive of oil and gas) is more than $700 million (Table 7) of which nearly $200 million, or about 30 per cent, is attributed to U.S. offshore production.

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[20] D. F. Austin, "Manned Underseas Structures–the Rock-site Concept," Naval Ordnance Test Station Technical Pub. No. 4162, 1966.

[21] **Estimated costs covered by this recommendation for a 10-year level of effort are $50 million.**

Throughout the world, more than 65 dredging operations are currently exploiting such diverse products as diamonds, gold, heavy-mineral sands, tin, oyster shells, sand and gravel, and silica sands. Of these commodities, sand and gravel are the most important in terms of dollar value and only sand and gravel and oyster shell is mined offshore the United States. However, U.S. mining companies are exploring for and extracting minerals offshore in other parts of the world. Major offshore contributions to world production in addition to sand, gravel, and shell include the operations for heavy-mineral sands, mostly in Australia, and offshore tin operations near Thailand and Indonesia (the latter account for more than 10 percent of the worlds's tin). Marine diamond operations account for less than three per cent of the total mineral values produced offshore.[28] Although there currently is no offshore production of phosphate, extensive deposits are known and exploration activities are progressing in the more promising areas.

A. Organization

Most of the nearly 300 recorded worldwide marine mining operations are being carried out on an individual company basis. Some, particularly those for coal, are Government operations; others are consortium operations. There is no formal trade organization for the ocean mining industry,

Table 7
SUMMARY OF WORLD OFFSHORE MINING OPERATIONS
(1966)

	Minerals	Number of Operations	Annual Value (In Millions)
Dissolved Minerals	Sodium Magnesium Calcium Bromine	145	$165.4
Unconsolidated Minerals	Diamonds Gold Heavy Minerals Sands Iron Sands Tin Sands Lime Shells Sand & Gravel	71	179.8
Consolidated Minerals	Iron Ore Coal Sulphur	60	367.0
Total		276	$712.2

Source: Charles M. Romanowitz, Michael J. Cruickshank, and Milton P. Overall, "Offshore Mining Present and Future," presented at NSIA/OSTAC Ocean Resources Subcommittee Meeting, San Francisco area, April 26, 1967.

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[28] M. J. Cruickshank, C. M. Romanowitz, and M. P. Overall, "Offshore Mining Present and Future," *Engineering and Mineral Journal*, January 1968.

oxide, and they occur on the deep ocean floor as well as on the lower parts of the continental slopes.

5. Deposits in the Substrate of the Deep Ocean Basins

The rocks beneath deep ocean floors are believed to be principally basic and ultra-basic rocks of igneous origin. Therefore the types of mineral deposits that might be found in this environment are restricted to those commonly associated with the same kinds of rocks on land. Chromite and nickel appear the most likely. Soviet oceanographers have recently found pure chromite in sea floor rifts in the Indian Ocean. Deposits of the Red Sea type (described in the following section) are also likely in certain areas.

6. Metals Deposited from Submarine Hot Waters[22]

Copper, zinc, silver, lead, tin, and gold were found to occur in significant quantities in hot brines and metal-rich sediment in one of the deeps of the Red Sea in 1965.[23] Subsequent studies have revealed similar deposits in two other deeps.[24] One of these, the Atlantic II deep, has been estimated by F. T. Manheim[25] to contain the following concentrations in the upper 10 meters of sediment:

Per cent by weight

Copper	Zinc	Silver	Lead	Tin	Gold
0.90	2.6	0.008	0.10	0.002	0.0001

Iron and manganese are also present in large quantities. These metals, along with barium (in barite) and mercury (in cinnabar) are among the metals that in some deposits are thought to have a hot springs origin.[26] It seems likely that a variety of metalliferous deposits may be found on the ocean bottoms in association with submarine hot springs.

Whether or not such deposits of hot brine and metalliferous muds occur on U.S. continental shelves and slopes is wholly speculative, but superheated metal-rich Salton Sea brine[27] appears to be of the same origin and the Pacific margin is one of the tectonic belts in which comparable hydrothermal (hot solution) activity is taking place now or took place in the recent past.

The deep ocean floors beyond the continental margins contain vast amounts of manganese nodules and red clays. Other valuable minerals not now suspected may lie either on or beneath the floors of the deep oceans.

Recommendation:

Bathymetric charting of the deep ocean floors beyond the continental slope together with geologic and geophysical study of the deep ocean areas and appraisal of its resource potential should start in a modest way and build up to a funding amounting to about 25 per cent of the Continental Shelf and slope program within five years. The surveys should be at reconnaissance scale and the program of bathymetric, geophysical, and geological mapping should be closely coordinated. Priorities should be given to areas most likely to enhance knowledge of how mineral deposits are formed. Such areas would include the great fracture zones of the pacific, the mid-Atlantic Ridge, and the Red Sea rift zone.

II. Present State of the Marine Mining Industry

During 1967 there were nearly 300 recorded operations, worldwide, engaged in the production of hard minerals from marine sources, according to the Bureau of Mines. All of these operations are nearshore and involve extraction of minerals from three of the basic types of deposits: sea water;

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[22] Summarized from V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

[23] A. K. Miller *et al.*, "Hot Brines and Recent Iron Deposits in Deeps of the Red Sea," *Geochimica et Cosmochimica Acta*, Vol. 30, 1966, pp. 341-359.

[24] E. T. Degens and D. A. Ross, "Hot Brines and Heavy Metals in the Red Sea," *Oceanus*, Vol. 8, June 1967, pp. 24-31; J. L. Bischoff and F. T. Manheim, "Economic Potential of the Red Sea Heavy Metal Deposits," *Red Sea* (in press).

[25] F. T. Manheim, unpublished memorandum, Geological Survey, April 28, 1967.

[26] D. F. Hewett, "Stratified Deposits of the Oxides and Carbonates of Manganese," *Economic Geology*, Vol. 61, No. 3, 1966, pp. 431-461.

[27] D. E. White, J. D. Hemley, and G. A. Waring, "Chemical Composition of Subsurface Waters," Geological Survey Professor Paper No. 440-F, 1963.

unconsolidated placer deposits on beaches and the continental shelf; and bedrock deposits in the shelves. Current offshore mineral production on a worldwide basis (exclusive of oil and gas) is more than $700 million (Table 7) of which nearly $200 million, or about 30 per cent, is attributed to U.S. offshore production.

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[28] M. J. Cruickshank, C. M. Romanowitz, and M. P. Overall, "Offshore Mining Present and Future," *Engineering and Mineral Journal*, January 1968.

any such function being carried by the parent industry associations most closely connected with each operation. Lack of a mutually beneficial organization creates some problems in the flow of proprietary information.

B. Financing

Present financing for offshore operations is carried out on an individual company or private consortium basis.

C. Technology

Production of hard minerals from marine sources will be either governed or strongly affected by the following factors:

- –Size and shape of deposit
- –Physical character of deposit–whether unconsolidated placer, nodule, hard rock lode, or dissolved in sea water
- –Depth of water covering the deposit
- –Topography of seafloor (if deposit is on seafloor)
- –Depth of overburden or barren rock covering deposit
- –Distance from shore
- –Ocean currents
- –Sea state
- –Presence of ice over deposit in Arctic waters.

Commercial extraction of unconsolidated materials is limited at present to nearshore deposits in calm water. Generally speaking, offshore dredging costs are about double the costs of dredging on land. Depth capabilities are limited to 150 feet for bucket dredge, 300 feet for the less efficient hydraulic dredge and about 350 feet for grab dredges.[29] It is now possible to extend the capability of each dredging method about another 50 feet; the ultimate limits for the hydraulic and grab dredges may be very much beyond that. No equipment exists to exploit the phosphorite or manganese nodules in deeper waters. One of the major problems encountered in nearshore placer dredging is the effect of weather and seas. This was exemplified by the operations of Marine Diamond Corporation off South West Africa where extreme sea conditions contributed largely to the curtailment of operations and re-assessment of the situation.

Deposits in the substrate of the continental shelves are possibly exploitable by lock tube in water depths as great as 300 feet, but significant resources may be present in shelf and slope rocks well beyond this depth.

The present programs of mining corporations generally are limited to conceptual designs and small-scale engineering work pending future technological breakthroughs in ocean engineering.

Recommendation:[30]

Development of the basic technology which must precede the development of operational mining equipment should be a function of Government in cooperation with industry.

Government and industry should work in close cooperation to develop marine sampling systems and improved delineation techniques and equipment, but the actual delineation of mineral deposits should be carried out by private industry.

A Government agency should have the function of testing the tools and equipment developed mainly by private industry, developing measurement instrumentation used in mining research and development, and setting standards for the mining industry.

This agency should be the source of information on the results of experience of industry and other Government agencies with underwater equipment and materials. It should serve as a medium for evaluating classified marine data and it should determine with the Department of Defense

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[29] O. G. Herrman, *"Schwimmende Greiferbaggeranlage Einschliesslich Aufbereitung an Bord mit Verladung des Materials in Schiffe," Aufbereilungs-Technik,* 1968, n. 2.

[30] Estimated costs covered by this recommendation for a 10-year effort are $130 million.

how critical information relating to underwater technology can best be made available to industry.

Ocean mining equipment and installations should be capable of functioning uninterruptedly and of enduring years of adverse sea conditions. This requires not only durability in the face of tremendous extremes of weather and sea conditions but also resistance to the powerful corrosive forces of sea water and organisms. The resistance to sea water corrosion of materials from which tools and machinery might be built is not well known.

Recommendation:

A more comprehensive program for materials testing, data reporting, and interpretation of test data should be organized. An advisory board of marine materials authorities from industry, universities, private institutions, and Government should be established to guide the programs of the various agencies for materials testing.

D. U.S. Capabilities To Use Marine Resources

1. Unconsolidated Deposits

Although the placer mining industry in this country has been much neglected during the past 25 years the problems of working in the nearshore areas have been well defined by the operations of the offshore oil industry during the same period. Mining problems will relate mostly to motion in surface platforms, excavation, control, materials handling, and beneficiation. Marine corrosion and biological fouling are important aspects which will become more obvious problems as operations are developed.

It is a common assumption that dredging or other types of seafloor mining may be a major source of pollution and that mining will be generally incompatible with other resources and uses of the marine environment. However, no definitive study of this problem has been made. Meaningful economic evaluations of offshore hard mineral resources will probably be impossible in the absence of reliable information on the amount and kinds of pollution that may result from the extraction of mineral resources.

Recommendation:

A comprehensive study should be made to determine the amount and kinds of pollution that may result from seafloor mining operations and the potential effects of such pollution on the living resources and on the overall quality of the marine environment in the area where mining is done. Such a study should also determine what beneficial effects other than mineral production might result from sub-sea mining.

The prospective capability to carry out large scale exploitation of materials from the deep sea floor using totally submerged systems is probably 10 to 15 years distant, depending on the incentive.

a. Hypothetical Offshore Dredging Operations in Shallow Water Two hypothetical dredging operations are evaluated (see Appendix C for detailed evaluations) to bring some of the problems of submarine mining into clearer focus. One is a gold operation in Norton Sound off Alaska where severe weather conditions prevail during a large part of the year, limiting operations to 185 days out of the year; the other assumes a gold operation in waters where less severe environmental conditions prevail, as off the coast of Oregon where operations might be conducted 362 days a year. Basic assumptions made about both deposits are:

–They are located one mile offshore;

–The combined depth of water and deposit thickness does not exceed 150 feet;

–The deposit is amenable to standard bucket line dredging methods giving a recovery factor of 90 per cent;

–The average grade of the deposit is 75 cents per cubic yard, with reserves equal to the 20 year life of the dredge;

–The estimates are basically engineering cost valuations.

Increasing the working time reduces the operating costs considerably. In Norton Sound costs are 22.9 cents per cubic yard for a 185 day per year operation, whereas costs are 16.5 cents per yard on a sheltered coastline where operations can be conducted 362 days per year.

Annual return on initial investment is estimated at 5.4 per cent for the Norton Sound operation and 11.7 per cent on the sheltered coast. Both operations would pay off within the 20-year life of the dredge. However, it is unlikely that either would be considered an attractive investment commensurate with the high risk involved. Higher ore values would of course greatly improve the attractiveness of the operation.

b. Hypothetical Deep Sea Manganese Operation An economic evaluation of a hypothetical manganese nodule operation (see Appendix 3 for detailed evaluation) made the following assumptions that:

–The deposit is located in the East Pacific 1200 miles south of Los Angeles and 2500 miles east of Hawaii in water 15,000 feet deep.

–The ore analyses Mn, 24.0 per cent; Ni, 1.4 per cent; Cu, 1.2 per cent; Co, 0.25 per cent; SiO_2, 16 per cent; and $CaCO_3$, 3.5 per cent.

–Lime content is low compared to the silica content, a factor that reduces the cost of metallurgical processes.

–The production rate is 5000 tons per 24 hour day.

–Nodule density is two pounds per square foot.

–Reserves are equal to a 20 year assumed life for the mining system (30 million tons extending over 1100 square miles).

–The seafloor in the deposit area is flat and of sufficient strength to support a mining operation.

–The mining system will involve eight components, the deposit, a scraper-type mining vehicle, a central control habitat, a hydraulic hoist or pumping system, a floating surface station, a deep submerged personnel transport and work vehicle, a surface transportation fleet, and an offloading and reduction plant onshore. Development costs of these items are not included here but are estimated in the range of $50 to $100 million.

Profitability analysis is made in two cases, with and without manganese included in the sales of the product. Returns on initial investment of 9.8 per cent and 5.2 per cent are indicated, using standard percentage rates for administrative and selling expense, royalties, taxes, depletion allowance, and working capital, although it is not clear just how domestic taxation and allowances would apply to an operation of this nature.

For the amount of capital involved even the 9.8 per cent return is considered marginal, but considering the conceptual nature of the estimates the possibility of improving on the economics of such an operation should not be dismissed.

2. Consolidated Deposits

With modern-day shaft and tunnel boring techniques, access to the sea floor from land can be carried out at depths beneath the sea of several thousand feet and at distances offshore up to hundreds of miles.[31] However, the cost of boring an opening ranges from $1 to $1.5 million a mile. The possibility of economically developing a hard rock deposit by this method is probably restricted to a distance of about five miles from shore.

Sea bed entry at distances of more than a few miles from shore would be better accomplished by vertical shaft or tube, using a lock system to seat the exposed part of the tube, after which the mine would be open to the atmosphere and operated at normal atmospheric pressures. It is estimated that the cost of the shaft might be twice that of comparable installations on land but there are otherwise no special costs or techniques. Land underground mining techniques could thus be fully transferred to the sub-shelf environment at depths of at least a few hundred feet, at distances several hundred miles from shore. Any mineral that occurs in large thick deposits beneath a cover of impervious rock (lending itself to low-cost underground mining) and that sells for more than, say, $10-15 a ton would therefore be recoverable from much of the sub-shelf under present economic and technologic conditions.[32]

Deposits that are amenable to *in situ* mining, for example sulphur and potash, may be economically exploited at the present time in water depths where large stationary platforms may be located.

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[31] Austin.

[32] V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

This is currently limited to bottom standing platforms in depths up to 250 feet, but technology may even now be sufficiently advanced to permit operation in depths up to 600 feet.

E. Foreign Capabilities

Foreign capabilities do not differ significantly from U.S. capabilities except that foreign technology in offshore dredging is probably more advanced than that in the United States at the present time. The gap, however, is slight.

F. Potential Impact of Marine Mining on Land Mining[33]

What effect would the increase in mining of marine resources have on the mining of land resources? Technologic and industrial impacts receive some notice, but the impact on political jurisdiction, lease policy, and related matters are not considered in this section.

Only those mineral resources that seem to offer the greatest possibility of being recovered from the sea are discussed here. Oil and gas are excluded. Also, for present purposes marine mining will include only those mineral recovery processes (apart from oil and gas drilling) in which the water surface is penetrated. This definition covers marine mining as commonly understood but excludes mines that happen to extend out under the ocean from land-based entryways and those that work marine beaches.

1. Impacts on Technology and Industrial Organization

The technology of mining has been relatively straightforward, advancing relatively slowly. While there seems little likelihood that marine mining will alter the basic extraction sequence, it will require—at least for those minerals occurring at greater depths—a new mining system. In many cases, as with the hydraulic mining that has been proposed for recovery of manganese nodules, the application to land resources is likely to be quite limited. However, the rigors of the marine environment may spur consideration of exploration and production technologies that will be applicable to onshore resources (solution mining, for example). In the case of Frasch sulphur, the similarities between onshore and offshore recovery certainly outweigh the differences; of course, in this case the offshore technology was adapted from the onshore, but the reverse could be true in other circumstances.

In addition, the recovery of marine mineral resources may require developments in associated technologies that will be applicable to onshore resources. A possible example is development of beneficiation processes that follow from the need to treat the very fine grain size typical of precipitates like manganese nodules.

Finally, there is the potential of marine mining industry as a whole to increase its level of support for research. Only recently has the extractive industry, apart from oil and gas firms, begun to engage in extensive research. To the extent that additional research is stimulated, marine mineral resources should be credited with an important impact regardless of whether they are actually recovered.

The potential impacts of marine minerals on industrial organization are not unrelated to the need for new technology. The technologies needed for successful marine mining may not be those most commonly found in the onshore mining industry. Moreover, it is widely recognized that most forms of marine mining will require significant inputs of investment (and, at the start, risk) capital. These factors suggest that large firms, and perhaps joint ventures among large firms, which include some participants from outside the traditional mining industry, will be likely to take the lead in developing most marine resources. Thus, the potential of marine mining can be expected to contribute to the already existing trend toward larger and more widely integrated firms in the mining industry. If so, these firms or joint ventures will probably be financially stronger and technologically more proficient and they might well apply this strength to onshore as well as offshore resources.

2. Impacts on Markets

The most direct impact that marine mining would have is in the marketplace, where it would stimulate the competition to satisfy the demands for mineral resources. The purchaser of minerals, it must be remembered, is generally indifferent as to the source of supply; his basic criterion is price. Thus, the question arises as to which of the many metals and compounds that might be recovered from marine sources will be able to compete against identical commodities recovered from onshore sources. The answer to this question lies in part in physical occurrence, a matter of geology, but more importantly it lies in the feasibility of large-scale recovery, a matter of technology and economics. (A third factor, inability to gain access to markets because of corporate or governmental controls, is not considered here.)

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[33] This section is based on written material supplied by David B. Brooks, Chief, Division of Mineral Economics, Bureau of Mines.

The question of the likely competitive standing of marine mineral resources can be better delineated if the commodities most abundant offshore are divided into three groups.

First, there is a group in which marine recovery already dominates the market. Among this group are magnesium and magnesium compounds, bromine, and shell (locally), and in some areas of the world, sodium compounds.

In certain of these cases, as the bromine and shell, land resources are so inferior in quantity if not in quality that there is little question of the dominance of ocean sources. In other cases, as with magnesium, onshore sources continue to exert a strong competitive influence. Except for shell, these commodities are recovered from sea water, so that capacity is set only by plant size and not by the characteristics of a deposit. In any event, ocean sources set the competitive standard against which land sources must compete. Thus, there is little need to consider this group of commodities further; they have proved their ability to compete and their main impact on land resources has already been registered.

A second group of commodities lies at the opposite extreme. These are the commodities for which no reasonably likely scale of marine mining would have a significant impact on world markets. In this group are boron compounds, copper, gold, iron, and platinum. Gold, in particular, is being located in offshore placers and such deposits may come to be a major source of supply. The implication of placing gold in this second group does not deny this possibility but only indicates that offshore recovery is unlikely to affect the $35.00 per ounce price. In effect, sand and gravel and calcium compounds can be added to the list, though they may be important competitors locally. As with the first group, these commodities need not be considered further.

Thus, the import of the question comes down to a third group, those commodities that are sufficiently abundant in the oceans to make a significant impact on world markets but for which an economic recovery technology needs to be developed before the potential can be realized. Perhaps most interesting of the commodities in this group are the phosphorite nodules and manganese nodules (containing cobalt, copper, and nickel as well as manganese). Other possibilities include barium, potassium compounds, and strontium. In addition, the group must include commodities that are already recovered in part from the ocean but from which a greater impact would occur with additional technologic improvements: diamonds, sodium and sodium compounds, sulphur, and heavy minerals (in particular zirconium, tin, and titanium minerals). These are the commodities that require additional attention.

Phosphorite nodules would presumably be mined as an input for fertilizer production. As such, they would have to compete against onshore phosphate deposits that typically are not only of higher grade but also relatively easily worked. Therefore, the potential of offshore sites depends upon locational advantages, areas far from present sources of supply. These circumstances, together with the rapidly rising use of fertilizers the world over, indicate that offshore phosphate mining, even when it becomes feasible, will have relatively little impact on conventional sources. In most places new offshore sources are more likely to increase the rate of use of fertilizer products than to substitute for onshore sources of supply.

The situation is quite different with manganese nodules. All indications are that when and if deep sea mining becomes feasible, production of manganese nodules will have to be maintained at a high rate, certainly high enough to have an effect in the market place.

Of the four most abundant metals (apart from iron) in the nodules, manganese and cobalt are most vulnerable to market impact, nickel somewhat less so, and copper essentially immune. Reasonably likely rates of mining by a few ships could supply anywhere from 10 per cent to 100 per cent of total U.S. consumption of manganese and much more than current consumption of cobalt. While cobalt is a byproduct, it is a relatively expensive one, and production from existing sources might be curtailed to cushion the shock. But with manganese, at least some existing sources are both rich and inexpensive to mine, although they suffer from a locational disadvantage, they could withstand large price cuts before leaving the markets. It is impossible to predict the impact. However, under one hypothetical but reasonable projection it is estimated that the price of manganese in ore (standard grade) would fall to around two cents per pound.[34] The impact on nickel would be considerably less; it could depend upon the response of the International Nickel Company to the new source of supply. In any event, it seems clear that manganese nodules do have the potential for taking some markets away from onshore sources, and, if they did, the impact on at least the higher cost sources could be disastrous.

The several commodities that can be recovered from seawater–sodium and sodium compounds, potassium compounds, and strontium–can be treated together. In each case, the conclusions must be that the seas form so large a reserve that the scale of an economic recovery plant would form the only limit on output. In other words, marine resources could dominate the markets if enough, or if large enough, plants were built. If all the chemicals were recovered from, say, a nuclear power-desalination plant, more than enough of these commodities would be recovered to satisfy U.S. needs.

While only a small proportion of our salt is recovered from the sea today, and almost none of our potassium and strontium, the potential certainly exists to alter the situation. However, the prospects vary. Sodium is the most abundant metal in seawater and common salt could provide the greatest revenue from recovery; yet it is also remarkably cheap to mine from onshore sources. The market impact might well be reflected in a fall in price and possibly in the closing of some of the older conventional mines. The outcome is not presently clear.

Assuming salt can be recovered profitably, it is probable that other metals will also be extracted; and, conversely, without salt recovery the others are not likely to be extracted. World demand for potassium compounds is climbing more rapidly than the demand for phosphorous. If the new source of supply does not enter the market too rapidly, it may find its way without substituting for onshore sources. Moreover, the new onshore sources are already forcing older conventional mines out of production and, representing very sizable investments themselves, they are likely to search out a way to accommodate the new source in the least disruptive way. Finally, in the case of strontium, seawater sources could flood the market; if production began in earnest, it would probably force out of business all of the relatively few producers of strontium minerals.

There is less to be said about the remaining commodities. The potential of recovering some of the high-barium muds is remote and onshore sources seem able to take care of requirements. It is unlikely that the proportion of sulphur recovered from sub-sea Frasch deposits will increase because of the growth in production from non-Frasch sources such as sour gas. Even if the proportion does rise, the demand for sulphur is expected to continue to grow strongly enough that any reasonable increase in marine production could be accommodated without significant long-term market impact. As for heavy minerals, including diamond, ocean production seems likely to remain a significant but not dominant part of supply. The situation parallels that of sulphur; barring an unforeseen drop in demand, ocean sources will hold their own and perhaps gain somewhat on conventional sources but without disruptive effects in the marketplace.

G. Legal Environment in Which Mineral Resources Can Be Exploited

The Outer Continental Shelf Lands Act of August 7, 1953 and the 1958 Geneva Convention on the Continental Shelf constitute the principal body of the law dealing with the exploitation of offshore mineral resources beyond the limits of jurisdiction of the individual States.

The jurisdiction of States has been fixed (by the Submerged Lands Act of June 1953) at three nautical miles from shore except along Texas and the Gulf coast of Florida where it corresponds to the three marine leagues (10.5 miles) limit that represents the historical boundaries of those States.

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[34] David B. Brooks, *Low Grade and Nonconventional Sources of Manganese* (Baltimore: Johns Hopkins Press, for Resources for the Future, Inc., 1966).

The 1958 Geneva Convention on the Continental Shelf defined the Continental Shelf to refer

> *(a) to the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas; (b) to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands.*

Inasmuch as experimental drilling has already been undertaken at a depth of 11,700 feet, it seems desirable that the limits of the continental shelves and slopes be extended to their bathymetric and geologic boundaries, or to some arbitrarily established depth or distance from shore that approximates these boundaries. For practical purposes, the U.S. continental shelves and slopes, as they would be defined bathymetrically, lie largely within the 2500 meter contour.[35] Conversely, not much of the ocean floor and continental rise extend coastward beyond this same contour.

Sulphur and other types of hard minerals may occur in the continental slopes as well as in the shelves. The slopes between the 200 and 2500 meter contours around the United States include about 479,000 square statute miles. Under present international law the United States does not have clear legal jurisdiction over the slopes.

Recommendation:

An international legal regime is needed that will provide protection for the mineral exploiter in waters seaward of the 200 meter isobath. A regime that the panel believes to be satisfactory is described in detail in the report of the International Panel.

The location of our boundaries with adjacent nations on the continental shelves and slopes has not been defined. Lack of definition of these boundaries will eventually lead to dispute when marine mining becomes feasible.

Recommendation:

The Federal Government should take the necessary steps as soon as possible to determine its offshore boundaries with adjacent nations.

The Outer Continental Shelf Lands Act was written principally to regulate oil and gas exploration and exploitation and may be inappropriate to the needs of the hard mineral mining industry. However, activities of the latter industry are at present governed by the Act. Under the provisions of the Act the Department of the Interior was vested with authority to issue oil and gas and mineral leases for the submerged lands of the Continental Shelf of the United States and to issue geological and geophysical exploration permits with respect to the shelf. The outer limits of the Continental Shelf were not specified as to depth or distance from shore by the Act. Recently the Department of the Interior issued leases on the coasts of California and Oregon where some or all of the waters above the leased tracts have been more than 200 meters deep[36] (as much as 1500 feet deep and 30 to 35 miles from shore). In the Atlantic the waters covered by exploration permits for geophysical work and core drilling are as deep as 3,000 to 5,000 feet and the areas are as much as 100 to 200 miles from shore. The fact that such leases and permits have been issued indicates that the United States believes that developers should be given an opportunity to ascertain whether the lands beneath these deeper waters are susceptible of exploitation. Thus, the outer limit of the Continental Shelf, as defined by the existing laws, is extremely flexible and vague.

Another area in which existing laws are not explicit pertains to the offshore boundaries of coastal nations. Where is the boundary between Maine and Nova Scotia 100 miles at sea? So far, exploration leases have not been requested in areas close to national boundaries that might be subject to dispute. But the problem is bound to arise sooner or later.

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[35] V. E. McKelvey, *et al.* "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

[36] Report by Solicitor, Department of the Interior, to National Council on Marine Resources and Engineering Development, Feb. 14, 1968.

Here is an example of how the Outer Continental Shelf Lands Act controls the operation of a typical (oil) company,[37] derived from remarks by Mr. Frank Barry, former Solicitor of the Department of the Interior, that the Act was designed principally for oil and gas production techniques. The question arises whether it is an adequate vehicle for the exploitation of other minerals. Representatives of the mining industry say that it is not. Interior's Bureau of Land Management, in a recent report to the Public Land Law Review Commission, stated that the OCS Act does not offer much incentive for exploration and extraction of minerals other than oil and gas.[38] BLM also pointed out that the present law offers no reward to the discoverer of a mineral deposit on the seafloor.

Spokesmen for the mining industry point out that fundamental differences exist in the philosophy, techniques, and costs of exploring for and exploiting oil and gas and exploring for and exploiting hard minerals.

The oil industry was easily attracted into the marine environment because the geology controlling the distribution of reservoirs commonly extends in uninterrupted sequence offshore. The same technology used on land, with modifications, was available to develop oil in progressively deeper waters. In the case of hard mineral deposits, only a few types of placers and bedded deposits like coal extend from onshore to offshore and the projection of favorable target areas is much more difficult. The oil industry has had long experience in evaluating concealed targets, and because of the highly efficient geophysical and geological techniques used in the exploration for oil and gas reservoirs, the ratio of discovery holes to total exploration holes is high.

In contrast, the mining industry has only recently attacked the problem of concealed targets because most of the rich ore deposits that have sustained the Nation's needs were exposed on land at the surface and discovered by surface prospecting. The technology and techniques for discovering concealed deposits, even on land, are still primitive and inefficient. The ratio of discoveries to targets explored is very low compared to that of oil and gas.

Virtually a whole new technology to search for offshore sub-bottom lode and bedded deposits will have to be devised. Offshore placer and nodule deposits will be somewhat easier to explore for than concealed bedrock deposits but will still pose considerable difficulties. A great many samples must be taken to define a placer deposit, and often the best material lies in cracks and depressions in the bedrock surface at the base of the unconsolidated material where it is difficult or impossible to reach.

Exploration costs are high for all concealed targets whether they be oil, gas, or mineral, but once an oil target has been located the discovery hole can be easily converted into a producing unit and extraction and operating costs are not excessive. In contrast, a discovery hole in a hard mineral deposit cannot quickly be converted into a production unit. Instead, the rate of exploration and development expenditure increases after discovery. The aggregate capital invested builds up substantially without any compensating revenue, usually over a period of several years.

Most important mineral commodities are products for world trade, and the market price is set over the years by those producers who can supply the demand at the lowest possible cost. Mineral developers must evaluate any exploration venture in the light of this world picture. They must eliminate prospects with the lowest geologic potential or poorest indicated financial return and concentrate on the most profitable.

Our Continental Shelf will be explored by private industry only if it appears that ore deposits which might be present can be discovered and extracted more profitably there than elsewhere. Favorable land and ocean mining laws of other countries put them in direct competition with U.S. offshore exploration dollars. If the United States wishes to develop–or even test the likely extent of its offshore hard mineral resources–it will have to entice private industry exploration dollars from other kinds of exploration, in the United States and abroad on land and on the shelves of other countries.

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[37] Material in the following paragraphs relating to the OCS Act is summarized from Remarks by Frank J. Barry, Solicitor, Department of the Interior, to American Bar Association, June 9, 1967.

[38] *Ocean Industry*, Vol. 3, No. 5, May 1968, p. 13.

At the present time it is extremely difficult to anticipate how the offshore mining business may develop or what kind of properties and mining procedures are likely to be attractive. The Commission has a responsibility for recommending that inappropriate laws do not smother a nascent industry. A system for assigning mineral exploration and development rights on the Continental Shelf should:

–Be sufficiently flexible to recognize the great diversity in knowledge, resource potentials, technology and the physical characteristics of mining operations.

–Rely on competition to the extent feasible. However, companies should not be exposed to any international uncertainty as to the prospect of being able to exploit mineral deposits which they have discovered through privately-financed exploration.

–Provide a reasonable economic rent to the public for the use of public lands and public data.

–Recognize that the U.S. Government, as lessor of Outer Continental Shelf lands, faces competition from other nations who may offer development rights to their offshore and onshore lands on terms calculated to attract mining enterprises.

Recommendation:

The Outer Continental Shelf Lands Act should be amended to allow the Department of the Interior greater flexibility in the management of offshore lands. The specific terms under which these lands are yielded to private development could be adjusted to reflect differences from case to case and over time in our knowledge of and capability to exploit mineral potentials. The amended legislation should establish the following options for exploring and for yielding exploration and minerals development rights on the Continental Shelf as defined in the Geneva Convention on the Continental Shelf, or, if recommendations of the International Panel are adopted, only to the 200 meter isobath or a distance of 50 miles, whichever is greater.

Where a promising minerals development opportunity has been identified by the Government or by Government-supported scientific institutions, bidding procedures should be used.

Where knowledge of mineral potential is too limited to permit successful bidding, and a company has expressed interest in exploration and/or exploitation, the Government should either contract to develop the data necessary to permit a competition for development rights, or announce in the Federal Register the applicant company's intent–absent objections–to explore the described area under a concession system which would also yield to it rights to develop any minerals which might be found.

Should any other company, within a specified time, indicate that it also has an interest in the exploration and possible development of the tract, the Department should conduct a competition among the interested companies for exploration and development rights.

Regardless of whether awarded as a result of bidding or negotiation, the rental and royalty terms which would apply under the permit should be specified before the permit would be granted or exploration begun.

A legal system somewhat analogous to the concession system practiced successfully in some foreign countries tentatively appears to be more appropriate to minerals development. The main provisions of such a system would include:

–A mineral explorer could obtain a permit for exclusive rights to explore a large area–say 100 square miles–on application. A large area under permit is essential in the beginning because any type of an anomaly would likely encompass a large search area. All minerals except oil, gas, and sulphur would be included.

–The permittee would be required to pay at least a nominal rental of $50 to $100 per square mile per year for the area held. Main purpose of the rental fee would be to discourage speculative holdings.

–Permittee would be required to do a minimum amount of work each year and would be required to turn back half the original area at the end of the first year, half the remaining area at the end of the second year, and so on. The minimum work obligation would increase on a sliding scale each year. The permittee would have the option of turning back the entire remaining parcel at any time.

–In the event of a mineral discovery, the permittee could convert all or any portion of the remaining permit area into a lease to exploit without competitive bidding. The lessee would have the right to extract any or all minerals present except oil, gas, or sulphur.

–Lessee would be required to pay rental on the land and royalty on the gross value of minerals produced at the lease. Royalty and lease term would be negotiated.

–Upon expiration of the lease term renewal could be applied for if the deposit showed promise of future production. Otherwise the property would revert to the Government

For purposes of comparison with the Outer Continental Shelf Lands Act the key items of the statutory and regulatory schemes governing exploration and exploitation of mineral resources in the territorial seas of six key States–California, Texas, Louisiana, Alaska, Oregon, and Hawaii–are briefly summarized.[39]

CALIFORNIA

Relevant law –

Public Resources Code 6801-7062.

Administering agencies –

State Lands Commission, Department of Finance (oil and gas, other minerals, geothermal resources).

The Resources Agency has jurisdiction over matters pertaining to conservation.

Exploration rules for minerals–

Prospecting permits at cost of $1.00 per acre.

Application for preferential leases may be made at any time during life of a prospecting permit upon discovery of commercially valuable mineral deposits.

Leasing acreage –

Determined by administering agency, which has right to divide submerged lands into such size and number of parcels as will not substantially impair the public right to navigation and fishing.

Agency is authorized to offer for lease all lands classed as containing commercially valuable mineral deposits. Leased to highest bidder–qualified applicants.

Lease term –

20 years with preferential right to renew for 10 year periods.

Royalty –

20 per cent of gross value of all minerals produced.

In addition, each bid and lease shall provide for an annual rental payment in advance.

Administering agency in practice utilizes royalty bidding and awards lease to bidder offering highest royalty.

ALASKA

Relevant law –

Const., Art. VIII, title 38.

Alaska Stats. 38.05. 145-180; Alaska Administrative Code at Part 607.

Administering agencies –

Department of Natural Resources.

Division of Lands.

Exploration rules for minerals–

Can stake claim if two corners of the claim are on or above the mean high tide line. Otherwise, exploration permits are issued for duration of 10 years; no acreage limitation is now applicable. Permit fee is $20.00; rental is $1.00 per acre for first two years and $1.00 per acre for each year thereafter with expenditure credited against the rental. A permit may be converted to a mining lease if the permittee proves he has found a workable mineral deposit.

Leasing acreage –

Applications for non-competitive leases require a $20.00 fee and the area must have a survey and monumentation. Rental fee is $1.00 per acre per year with expenditures creditable against the rental. No maximum or minimum acreage is specified. Mineral leases may also be offered by competitive bidding on submerged land containing known deposits of minerals.

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[39] Summarized from report by Robert B. Krueger, Attorney, to Public Land Law Review Commission, April 1968.

Lease term –
Fifty-five years with right to renew.

Royalty –
Leases encompass all hard minerals located on the leased area with a single royalty for all.
Royalty not specified.

TEXAS

Relevant law –
86 Texas Revised Civil Statutes, Arts. 5249-5421m.

Administering agencies –
Commissioner of General Land Office issues exploration permits. School Lands Board is responsible for leases.

Exploration rules for minerals –
Permits not to exceed 640 acres are good for one-year periods but may be extended in additional one-year periods not to exceed five years. Rental is $0.25 per acre first year and not less than $1.00 per acre in subsequent years. Permits require quarterly affidavits regarding work done, samples taken, and results of sample analysis.

Leasing acreage –
Not in excess of 5,760 acres. Usual size is 2,500 acres. Sealed bidding procedure.

Lease term –
Primary term is five years and so long thereafter as minerals covered are produced in paying quantities.

Royalty –
Minimum royalty of one-sixth the value of uranium, thorium, and other fissionable minerals, and one-sixteenth for other minerals.

LOUISIANA

Relevant law –
Louisiana Revised Statutes, title 30.

Administering agencies –
State Mineral Board.
Louisiana Department of Conservation and Commissioner of Conservation have jurisdiction over production.

Exploration rules for minerals –
No discrete hard mineral leasing policy; subject to same rules as oil and gas. Exploration permits must be obtained for geological and geophysical surveys.
Explorer must provide survey data information if a lease is obtained.

Leasing acreage –
Maximum area is 5,000 acres per lease.

Lease term –
Primary term five years, and as long thereafter as production continues in paying quantities.

Royalty –
Minimum royalty is one-eighth for all minerals except sulfur and potash. Currently the Board uses a combination royalty and bonus bid.

OREGON

Relevant law –
Oregon Revised Statutes, Sections 273.355 and 274.705-.865.

Administering agencies –
State Land Board. Conservation is responsibility of State Department of Geology and Mineral Industries

Exploration rules for minerals –
Not specified.

Leasing acreage –
Not specified.

Leasing term –
No time limitation, but State may cancel any lease upon failure by lessee to exercise due diligence in prospecting, developing, or continuing operation of the property.

Royalty –
Not specified for hard minerals.

HAWAII

Relevant law –

Revised Laws of Hawaii, title 12 (1955), Chapter 103.

Administering agencies –

Department of Land and Natural Resources.
Board of Land and Natural Resources.

Exploration rules for minerals –

No distinction made between hard minerals and oil and gas.

Permit must be obtained and permittees must turn over drill logs and results of assays to the Board.

Leasing acreage –

Applicant must file a notice of his desire to apply for a lease on land where discovery is made. A fee of $100.00 is charged. Acreage is prescribed by the Board (which may also deny the lease). Maximum lease covers four square miles but no limit to number of leases.

Lease term –

Not specified.

Royalty –

Not specified.

It is evident that the regulations of various States differ markedly with regard to offshore mineral exploration and exploitation; some coastal States apparently have no provisions for issuing offshore exploration permits. The lack of permit regulations in some States and the lack of uniform regulations among various States and the Federal Government may be a deterrent to offshore mining because it leads to uncertainties over prospectors' rights and lease rights.

A National Conference of Coastal States was called to meet on Dec. 11-13, 1968 in Portland, Oregon. Representatives of a number of industries interested in coastal waters also participated in the conference. The purpose of the conference was to develop specific guidelines on hard mineral mining from submerged lands under State control. The results of the conference were unavailable as this report went to press. However, it is hoped that the conference considered and recommended action on the problem of providing a permit system that would clarify and safeguard the mineral explorer's rights in areas under State jurisdiction. If the action discussed above was not taken, the panel makes the following recommendation:

Recommendation:

The Department of the Interior, in concert with representatives of the mining industry, should develop a model system for assigning minerals exploration and development rights along the lines recommended above, for consideration by the States. The appropriate Federal agency should sponsor a convention of coastal States to consider the model and other legal and economic problems of offshore mining.

III. PRESENT LEVEL AND STRUCTURE OF GOVERNMENT ACTIVITY

Programs directly relevant to the development of marine hard mineral resources are conducted by three agencies in the Department of the Interior: Geological Survey, Bureau of Mines, and Bureau of Land Management. The National Science Foundation also funds basic oceanographic research projects that contribute to understanding of marine mineral resources, and the Office of Naval Research, which focuses its research and activities on the needs of the Navy, underwrites projects related to marine mineral resources. The environmental measurement and charting programs of the Navy and of the Environmental Science Services Administration of the Department of Commerce are also relevant.

The organization and structure for developing and managing marine mineral resources at the State level is extremely varied. In some States responsibility is assigned specifically to a single agency, whereas in others it is divided among several agencies. A number of States consider offshore mineral resources a simple extension of onshore authority. Others view the change in the basic environment as requiring additional interfacing with affected agencies.

A. Federal

1. Geological Survey

The principal objective of the Geological Survey's marine program is to make a three-dimensional geological analysis of the continental shelves and slopes in order to:[40]

–Appraise the undeveloped mineral, water, and energy resource potential on and beneath the sea floor, delineate broad target areas to stimulate detailed intensive exploration by private industry, and insure the public a fair income from the mineral resources exploited from the offshore public domain.

–Study marine geologic processes to develop new criteria to aid in the search for resources both on land and beneath the sea.

–Acquire geologic knowledge to alleviate loss of life or property resulting from geologic hazards such as earthquakes or engineering hazards related to slope or sea floor stability and to guide private and governmental construction and other subsea operations.

–Provide geologic and hydrologic analyses and interpretations in coastal areas and estuaries in order to analyse the interaction of man-made pollutants with geologic environment, and the control exercised by the geologic environment on the dispersal of pollutants.

–Assemble geologic information essential to management or policy decisions relative to marine mineral resources and to planning for compatible multiple uses of coastal areas and sea beds.

–Contribute fundamental knowledge of the history and origin of the continental margins and deep ocean basins and the relation of this history to the localization of mineral resources.

–Contribute to National and international programs of exploration and development of the world's ocean resources by providing geologic data needed to guide sovereignty determinations and by assisting emerging nations in development of their marine resources.

–Provide a focus for the assimilation and interpretation of geologic data derived from programs of other Federal and State agencies, universities and institutions, and industry.

The Geological Survey is subdivided into seven divisions: Geologic, Topographic, Water Resources Conservation, Publications, Computer, and Administrative. The marine geologic and hydrologic work of the Survey is conducted by the Office of Marine Geology and Hydrology of the Geologic Division. Direct funding in FY 1968 was $1.2 million. Additional funding of $1.4 million was provided by the Heavy Metals Program, making a total budget of $2.6 million. Total budget requested by the President for FY 1969 was $2.4 million.

The work of the Survey is accomplished in four ways: by in-house research; through research contracts with universities and institutes (currently 11 university contracts total about $900,000); service contracts with industry; and cooperative programs with other Federal agencies, including Bureau of Mines, Bureau of Commercial Fisheries, Naval Oceanographic Office, Naval Undersea Warfare Center, and ESSA.

The supervision and management of marine mineral resources is the responsibility of the Branch of Oil and Gas Operations, Conservation Division of the Geological Survey. The level of funding in FY 1968 was $0.6 million. An increase in funding to about $1.3 million for FY 1969 has been recommended.

2. Bureau of Mines

The marine program of the Bureau of Mines can be divided into two sections: the heavy metals section dealing with placer deposits and the "core" section which include BM activities relevant to all other types of marine mineral resources. Each of these programs can be further broken down into two parts:

–Delineation technology. Programs in this part are concerned with the development of tools, instruments, and techniques for the identification of all distinguishing features of marine mineral deposits. (In support of this objective the Bureau operates the *Virginia City*, a 205-foot vessel equipped with drilling rigs, an assay laboratory, and geological equipment.) Such information is combined with available knowledge of the particular marine environments to develop engineering representations or models of the physical situation at a site. From these data the proper mining systems can be designed and developed for a given set of physical conditions.

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[40] From statement by Director, Geological Survey, to the Commission on Marine Science, Engineering and Resources, Oct. 12, 1967.

–Production technology. Programs in this area are concerned with the development of equipment and techniques for the actual production and extraction of minerals by industry once the physical situation has been adequately defined by programs in delineation technology. The emphasis is on developing methods to recover marine minerals in a manner compatible with other uses of the environment.

The Bureau conducts a General Orientation Program for industry at its Marine Minerals Technology Center in Tiburon, California. The purpose minerals field, help them decide where their interests lie, and determine possible opportunities for their own commercial ventures on the sea floor. In April 1968 five companies were participating in this program. Each company assigns a representative for one year, pays his salary and expenses, and pays the Government $25,000 to help offset some of the costs of the program.

3. Bureau of Land Management

The BLM has responsibility for the leasing of lands on the Outer Continental Shelf. The Bureau does not participate in research projects. The lands which BLM may lease are those beyond the territorial waters of the States, out to the 200 meter isobath, or beyond that depth if the Secretary of the Interior approves. The BLM also prepares leasing maps whenever interest is shown in a particular area. The Bureau presides over lease sales. After a lease has been in operation for one year it is turned over to the Geological Survey for management. Thereafter the returns from the leases are sent to the BLM, which transmits them to the Treasury.

The jurisdiction of the States and Federal Government with regard to offshore lands is at issue in several instances and a number of court cases are pending. The BLM does much of the fact finding for the Department of Justice in these instances.

The 1968 level of funding for BLM was about $100,000. A funding of $400,000 has been requested for FY 1969.

Programs of other Federal agencies that contribute indirectly to the understanding and successful exploitation of marine resources include certain of those of the Navy, NSF, and ESSA. However, the principal goals of these programs are not to appraise and develop mineral resources, and their funding is based on other factors.

B. State

A State-by-State appraisal (covering coastal States) of organizational structure relevant to nonliving marine resources conducted by John I. Thompson & Company[41] indicated wide variances in structure, attitude, interest, and method of operations, as shown in Appendix B. States enjoying oil and gas benefits, such as Louisiana and California, are most cognizant of the various problems, have the largest staffs, and expend the most monies in managing marine resources, whereas States with little or no current activity have scanty knowledge of the problems.

Some of the problems and conflicts encountered by the States are:

–Lack of State laws to encourage or guide exploration and exploitation of marine hard mineral resources.

–Conflicts with fishing interests, particularly relating to geophysical work.

–Conflicts with sportsmen and recreation developments.

–Determination of boundaries between State and Federal jurisdiction.

–Prevention of pollution.

There is no set pattern to the interstate agency structure for planning and coordinating State programs or efforts to exploit marine mineral resources. The Interstate Oil Compact Commission is an advisory and coordinating body and serves as a forum for discussion among 33 oil producing States. Its prime responsibility is promotion of maximum utilization and conservation of natural oil and gas resources. No such organization exists with respect to hard minerals.

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[41] Subcontract study report to Commission on Marine Science, Engineering and Resources, 1968.

IV. OPPORTUNITIES TO IMPROVE MARINE MINERAL RESOURCES USAGE AND DEVELOPMENT

A. Gaps in Basic Knowledge

During the last few decades, there has been an increase in geologic understanding of how different kinds of mineral deposits were formed. During the same period, geophysical and geochemical prospecting tools and techniques have become more sophisticated. These gains have permitted discoveries of deposits buried at some depth below the earth's surface or deposits whose presence was otherwise too inconspicuous to be detected by the traditional prospector. Such deposits have been found not only in the United States, but in many parts of the world.

Nevertheless, the capability of finding unexposed deposits is advancing very slowly and there are still serious gaps in our understanding of fundamental geologic factors controlling the localization of mineral deposits. Many of these gaps apply to offshore as well as land deposits.

Some of the more important basic knowledge gaps which, if filled, would enhance our understanding of the distribution of mineral resources in the marine geologic environment as well as on land are these:

–The geologic and geophysical nature of the interface between the continental crust and the deep ocean basin. Although this interface is the most fundamental geologic boundary on earth, little is yet known about it.

–The age and landward continuity of the great ocean fracture systems such as the Mendocino, Murray, and other systems. Are these systems really restricted to the oceanic crust as they appear to be or do they continue beneath the continent? Are there mineral resources associated with them?

–The concept of seafloor spreading and its relation to structure at the margin of continents.

–The history of structural development of the deep sea trenches such as the Aleutian Trench, Japan Trench, Philippine Trench, and others.

–The origin and history of formation of Tertiary eugeosynclines and their relation to continental accretion.

–Geologic and petrological study of worldwide subaerial and submarine middle-Tertiary volcanism.

–The location, geometry, and geologic history of sediments forming the continental rise.

–Systematic investigation of the abyssal ocean floor to understand the geologic history of deep ocean basins, including the exceptional cases of small oceanic basins such as the Gulf of Mexico and Caribbean Sea, which possess thick sedimentary sections and are considered to have a potential for petroleum and other resources.

–The relationship between the geochemistry of manganese nodules and the enclosing seafloor sediments; the source of nickel, cobalt and other metals in the nodules and their growth rates.

–Submarine lithification and diagenesis of sediments and basalt.

B. Gaps in Technology That Restrict Exploration for and Evaluation of Marine Mineral Resources

Only a very small amount of exploration for hard minerals has been done on the continental shelves to date. Too little is known about the overall geology and mineral potential of the shelves and slopes to induce industry to spend significant sums of money on exploration in the marine environment. However, given specific target areas that might be pointed up by geological and geophysical surveys, by more efficient exploration equipment, and by a favorable legal environment in which to operate, the larger mining companies might undertake offshore exploration on a significant scale. Much new technology is needed to identify and evaluate the resources and there are requirements for development of the following:

–Inexpensive, rapid drilling and coring equipment.

–Inexpensive deep sea vehicle facilities from which underwater geological observations, sampling, and other geophysical-geochemical surveys can be made more readily.

–Greater submergence time for deep sea vehicles, permitting increased underwater working time.

–More precise navigation systems. The location of a drill hole with respect to others in a drilling pattern should be measurable to within less than 10 feet and preferably to within a foot if the size and grade of a mineral deposit is to be rigorously evaluated. Lease boundaries need to be determined accurately from surface craft. At present these jobs would have to be done in a very expensive manner: by sending divers down to measure the distances. Under the National Navigation Planning program, the Coast Guard is now investigating the inadequacies of present systems.

–A variety of sensors that could be used to make *in situ* engineering measurements relevant to the strength and behavior of seafloor sediments, geochemical parameters, and physical properties of sediments at depth.

–Remote sensing equipment and *in situ* geophysical devices to aid in determining geologic rock types and subsurface structures and in searching for unexposed mineral deposits.

C. Gaps in Technology and Engineering That Restrict Exploitation of Marine Mineral Resources

A new system of technology and of engineering techniques will be required if hard minerals are to be extracted successfully from a variety of geologic settings in the marine environment. Much of the needed technology will require a long lead time to develop. Although the need for serious exploitation of offshore mineral resources is probably a couple of decades in the future, it is prudent to begin development of the technological capability now to ensure its availability. Private industry will undoubtedly participate heavily in the development of tools and techniques but it appears that, because of the distant and uncertain returns, substantial Federal funding as well as Federal coordination of research and development will be necessary until a viable industry becomes established.

Some of the more important technological gaps are:

–Remotely controlled mining machines to mine placers and other stratified materials from the sea floor.

–Adequate power sources to mine and process minerals at sea.

–Sufficiently strong corrosion-resistant metals to build mining machinery.

–Knowledge of how ore beneficiation processes carried out aboard ship would be affected by ship motion. At present corrections for this motion are made by guess of the operator. Limiting factors are unknown.

–Knowledge of the effects of platform motion on positioning and digging efficiency of mining machinery.

–Information of how submerged placer material can efficiently be penetrated, disintegrated, and gathered into the mouth of a hydraulic dredge.

–Knowledge of how heavy placer minerals can be gathered from cracks and openings in the underlying bedrock. Many heavy minerals such as gold are concentrated in cracks up to two feet deep in bedrocks and are lost in present dredging processes. Can a method of penetrating bedrock to a depth of two feet or more in dredging operations be developed?

–Definitive knowledge of what type of dredging platform (or platforms) is most efficient. Controversies exist on optimum shape, size, hull type, and other factors.

–Information on how best to dispose of waste rock and the effect of disposal on ecological and physical environment.

–Knowledge of dynamics and mechanics of bottom-sited platforms and how the seafloor will respond to the weight of heavy mining vehicles.

–Knowledge of the methods and mechanics of rock fragmentation under water.

–Knowledge of whether underwater beneficiation of minerals is feasible.

D. Inadequate or Restrictive Legal Environment for Private or Public Investment

The legal environment in which hard mineral resources may be explored and exploited is summarily described in an earlier part of this section. The present law relating to the Outer Continental Shelf was designed in response to the requirements of the oil and gas industry; representatives of the mining industry say that the law is a deterrent to hard mineral exploitation because a company which spends money in exploration and finds a deposit does not have the exclusive right to exploit it, as it has on land. The Public Land Law Review Commission is making a comprehensive study of this and other problems relevant to the OCS Lands Act and will make its report with any recommendations it deems necessary to the President and Congress in 1970.

More important, perhaps, is the situation in the territorial waters of the States where offshore hard mineral mining is most apt to begin. Because there has been little or no actual offshore mining, State laws generally do not provide for it. Some States have no provisions for issuing offshore exploration permits and there is a great deal of difference in the regulations of the various States. These factors lead to uncertainties in the minds of mineral explorers concerning their prospecting and leasing rights and constitute a deterrent to offshore mineral development.

E. Absence or Inadequate Level of Supporting Services by State or Federal Government

An important deterrent to offshore mining is lack of knowledge of "what's out there" and lack of adequate bathymetric maps on which to plot basic information. Industry cannot afford the expense of bathymetric charting and broad-scale geologic studies, and existing programs of ESSA and the Geological Survey are inadequate to get the job done within the next 20 to 25 years, when it will be needed.

F. Restrictions on Private Research, Development, and Production from National Security Policies

Military restricted zones, such as submarine transit lanes, occupy about six per cent of U.S. coastal areas and non-military activities cannot be carried out in these areas. With this exception, there are no other restrictive factors stemming from national security policies.

G. Education and Training Requirements

In the absence of firm estimates as to the degree of offshore mineral exploration and exploitation in future years, some idea of the educational requisites may be gained by a projection based on an assumption of activity. In 1965, U.S. offshore hard mineral production, including minerals extracted from sea water, was equal to 1.5 per cent of onshore production. If it is assumed that offshore production in 1985 will be 5 to 10 per cent of onshore production the numbers of newly trained professionals and technicians will be:

Engineers	2050 – 4,100
Technicians, all types	7800 – 15,600
Marine geoscientists[42]	850

V. ROLE OF FEDERAL AND NON-FEDERAL GOVERNMENT AND PRIVATE INDUSTRY: COMPLEMENTARY AND COMPETITIVE ACTIVITIES

The role of government in the field of offshore hard mineral resources as in the case of other resources is to appraise, manage, and conserve. The actual detailed exploration, development, and exploitation of the resources is normally the function of private industry.

The petroleum industry, which because of favorable geological and technological factors was easily attracted into the marine environment, has been self-sustaining with only minimal governmental support services. The offshore hard mineral mining industry may require, at least in the early years, more substantial governmental assistance in the way of technical services and special incentives if it is to get started in an important way within the next couple of decades. This is because marine hard minerals are more difficult to evaluate and produce than offshore oil; the risks are greater, and the potential reward, at least initially, is much smaller. Moreover, a substantially new technology is required for marine mining, in contrast to what was needed for petroleum.

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[42] Figure for marine geoscientists is that required to make three-dimensional geological analysis of the continental margins.

The kinds of government involvement that will probably be necessary to get a viable marine mining industry under way are:

–The government (State or Federal) must develop and maintain a legal, economic, and regulatory environment that encourages exploration and development of marine mineral resources by private industry. This environment should take into account the problems of conservation and the multiple use concept. Existing laws and regulations, which were developed primarily in response to the requirements of the petroleum industry, are not applicable to the special requirements of the hard mineral mining industry. Industry would probably benefit if uniform State and Federal laws could be developed governing the exploration and exploitation of mineral resources from the territorial seas and outer Continental Shelf.

–The provision of adequate bathymetric base maps on which various kinds of information relevant to the exploration and exploitation of mineral resources can be plotted and with which various operations at sea can be more safely conducted should be a function of Federal Government.

–Establishment of the basic geological framework that will enable private industry to select favorable target areas for marine mineral exploration should also be a Federal function.

–Development of survey instruments, techniques and sampling devices and techniques applicable to the marine environment, together with provision of testing facilities for machinery and tools designed for underwater exploration and mining must be largely a Federal function because the potential expenses involved are too heavy and the returns too uncertain for private industry to take the risk. Much of this work could be done on a contract basis by industry. There may be some areas where government and industry could carry out joint study projects.

–A Federal Government unit such as the Bureau of Mines should accumulate and disseminate technical data on the results of experience of all government agencies and of industry with underwater equipment and materials.

–Advance information on storms, wave heights, and other environmental factors that might affect offshore structures and vessels are and should continue to be provided by the Federal Government. Forecasting needs to be improved.

–Special incentives may be necessary to stimulate the offshore mining industry in early stages of its development. These are given in detail in the Private Industry and Investment Panel report.

State governments have the responsibility for administration and management of resources in the territorial waters just as the Federal Government has responsibility on the Outer Continental Shelf. As with the Federal Government, State and local governments should do all they can to provide a favorable environment in which industry can operate.

It has been suggested that uniform laws and regulations among the various States and the Federal Government would be regarded favorably by industry and would be a useful goal toward which to work. The Department of the Interior could take the lead by working out a model' exploration permit with industry representatives and then calling a conference with representatives of State governments with the aim of getting the permit approved and implemented.

Industry's traditional role on land has been to conduct detailed mineral exploration surveys using the broader scale geologic maps and other data provided by the Government as a guide to favorable target areas. Industry delineates the specific size and shape of mineral deposits and exploits the deposits. The role of industry thus complements Government's role, and the two groups are not competitive. It is believed that in general our marine resources will be effectively developed by the same definition of Government and industry roles that has prevailed on land. Development of marine resources may in special cases require a somewhat larger Government effort than has been necessary on land.

In addition to its principal roles stated above industry would conduct research and development in areas of its primary interest. It would encourage educational and training programs to provide the necessary technological capabilities for Government-industry development of equipment and techniques needed in exploration, delineation, and exploitation of deposits.

Appendix A Demand Projections and Supply Potential for Individual Mineral Commodities That Are Known To Occur in the Offshore Environment[1]

BARITE

Uses. Principal uses of the heavy nonmetallic industrial mineral barite are as a weighting agent in oil and gas well drilling fluids and a source of barium chemicals. Lesser amounts are used in paints, rubber, and glass and as a high-density aggregate in concrete for nuclear shielding.

Present levels of utilization of barite in short tons.

World (1966)	4,054,000
United States (1966)	1,417,000

Range of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Steel production			
	Low	1,636,000	2,177,000	2,189,000
	High	1,749,000	2,470,000	3,552,000
Rest of World				
	Low	3,028,000	5,277,000	8,257,000
	High	3,098,000	5,643,000	9,119,000
Total World				
	Low	4,664,000	7,454,000	11,076,000
	High	4,847,000	8,113,000	12,671,000

Prospective supplies and prices. The land resource base for barite in the United States and the rest of the world appears adequate to support demand for the period of the projection but exploration and development will be required to fully identify the resources for the period 1985-2000. A rough estimate of prices follows:

Area	Estimated price	Quantity tons
United States	$12-24	First 30 million
United States	24-36	Next 30 million
United States	36	Next 17 million
Rest of World	8-24	First 60 million
Rest of World	24-36	Next 80 million
Rest of World	36	Next 48 million

Possible substitute materials. Celestite, iron ore, and galena are possible substitutes for barite as a weighting agent in drilling muds but barite is preferred to these other materials because it is clean to handle, relatively inexpensive, nonabrasive, inert, and has a relatively high specific gravity. Titanium dioxide has largely replaced lithopone as a pigment.

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[1] Information in this appendix on uses and on possible substitute materials is summarized from "Mineral Facts and Problems," Bureau of Mines Bulletin No. 630, 1965. Demand projections and data on prospective supplies and prices were prepared by Bureau of Mines commodity specialists.

Potential from marine sources. A few barite nodules have been found on the continental shelves but no extensive deposit is known. Barite occurs in large quantities in pelagic sediments of the eastern Pacific Ocean,[2] and barite might also occur as lode-type deposits in rocks of the continental shelves. A few small low grade occurrences are known in California, for example, in rocks that project into the shelves. However, the overall prospects for significant barite production from marine sources is poor.

BROMINE

Uses. The main use of bromine is in additives for gasoline. Smaller quantities are used in the manufacture of fireretarding and fireproofing materials, fire extinguishers, fumigating mixtures, sanitizing additives for swimming pool water, bleaches, photographic emulsions, laboratory reagents, and medicinal and pharmaceutical preparations.[3]

Present levels of utilization of bromine in pounds.

World (1966 production)	349,000,000
United States (1966 demand)	267,000,000

Range of demand projections in million pounds to the year 2000.

Area	Projection base		1970	1985	2000
United States	FRB				
		Low	343	654	1,200
		High	352	770	1,600
Rest of world	Time				
		Low	141	206	270
		High	141	227	315
Total world					
		Low	484	860	1,470
		High	493	997	1,915

Prospective supplies and prices. Bromine is recovered as a coproduct of magnesium in sea water and waste liquors from potash plants. Additional potential byproduct recovery may be feasible from oil field brines and desalting brines. Utilization of these potential sources would tend to increase available supply and lower processing costs. No new processes are known that would decrease costs of producing bromine products.

Bromine price levels are dependent on chemical extraction costs, pricing policy, and competition. Prices have been relatively stable at 32-33 cents per pound for a number of years.

Possible substitute materials. The chemical properties of chlorine and iodine are similar to those of bromine and these materials are sometimes substituted for bromine. Some substitutes for ethylene dibromide-tetraethyl lead antiknock fluid have been introduced, but the use of ethylene dibromide has continued to grow.

Potential from marine sources. Bromine, like magnesium, is obtained from sea water and the resource potential is therefore virtually unlimited. Demand and plant capacity will determine how much bromine is produced from the sea.

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[2] G. Arrhenius and E. Bonatti, "Eolian Sedimentation in the Pacific Off Northern Mexico," *Marine Geology*, Vol. 3, No. 5, 1965.

[3] Leo J. Miller, "The Origin of Sedimentary Phosphate Deposits," *Mining Engineering*, Vol. 16, No. 12, p. 87, 1964; *Economic Geology*, Vol. 59, No. 8, pp. 1619-1620, 1964.

CHROMITE

Uses. The only economic source of chromium is the mineral chromite. About 60 per cent of the chromite used in the United States is reduced to ferrochromium and used metallurgically in steel alloys to enhance strength and resistance to corrosion. About 28 per cent of chromite is used in high-temperature furnace linings, especially in the steel industry. The remaining 12 per cent of chromite is used to make dichromate as a basis for dyes, tanning, and chromate plating.

Present levels of utilization of chromite in thousands of short tons.

World (1966 production)	1,703
United States (1966 demand)	452

Ranges of demand projections in thousands of short tons to the year 2000.

Area	**Projection base**	**1970**	**1985**	**2000**
United States	Steel production			
	Low	550	775	1,050
	High	600	900	1,350
Rest of World	Time	1,350	1,900	2,475
Total World				
	Low	1,900	2,675	3,525
	High	1,950	2,800	3,825

Prospective supplies and prices. The world resource base is adequate to the year 2000 and beyond. However, the United States has depended on imported chromite since about 1880. Even when imports were interrupted by war, the United States was unable to obtain as much as half its needs from domestic deposits, which are small and low grade. World resources are mainly in the eastern hemisphere in countries of varied political stability.

United States and world prices of chromite are virtually the same when valued in the country of origin. Delivered price varies with the amount of transportation charges assessed. Typical prices of chromite in the country of origin during 1966 were: metallurgical grade, $21 per ton; refractory grade, $19 per ton; and chemical grade, $13 per ton. As the world resource base is adequate and the United States is completely dependent on imports of chromite, price in the future will depend on political decisions and development of technology in producing countries.

Possible substitute materials. Although magnesite may be substituted for much of the refractory grade chromite used in furnace linings, etc., there are no satisfactory substitutes for chromium in the metallurgical and chemical industries. Alloys, plastics, and various composite materials offer a wide range of possible substitutes for chromium-bearing alloys. Aluminum trim can be used to some extent in place of chrome-plated trim. A large scale research effort has been directed toward development of oxidation-resistant coatings for molybdenum, tungsten, and other high-melting-point metals. Future use of chromium-bearing super alloys will undoubtedly be influenced by this research.

Potential from marine sources. Chromite might occur in two ways in the marine environment: segregated (lode) deposits in ultramafic rock in the continental shelves, or as a constituent of black sands near the mouths of streams that drain onshore areas where ultramafic rocks occur in coastal areas of

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Potential from marine sources. Chromite might occur in two ways in the marine environment: segregated (lode) deposits in ultramafic rock in the continental shelves, or as a constituent of black sands near the mouths of streams that drain onshore areas where ultramafic rocks occur in coastal areas of northern California and southern Oregon.[4] No chromite deposits have been found within 40 miles of the Atlantic or Gulf coasts and consequently no offshore deposits can be inferred in these regions.

Inasmuch as the quantitative ratio of segregated chromite to ultramafic rock in the California-Oregon area is infinitesmal and no reliable means has been devised to locate chromite segregations under even a thin cover, it is unlikely that lode or bedrock deposits will be found in the continental shelves.

Black sands are a possible but not promising source of chromite in offshore deposits because most chromite in black sands is derived not from segregations but from accessory chromite in ultramafic which has a high (undesirable) iron content.

It has been estimated[5] that raised and modern beach reserves of chromite in Oregon contain three million long tons of black sand, two thirds of which may exceed 5 per cent of $Cr_2 O_3$ and the remaining third 3-5 per cent Cr_2O_3. The black sand beach and terrace deposits range from one to 42 feet thick up to 1,000 feet wide, and from several hundred feet to about a mile long.

In spite of the fairly substantial tonnage indicated in Table 1, the general outlook for offshore chromite production over the remainder of the century is poor in view of the fact that it has not yet been possible to mine similar onshore deposits at a profit.

Table 1
HEAVY MINERAL CONTENT OF BLACK SAND DEPOSITS ON THE CONTINENTAL SHELF OF SOUTHERN OREGON

Water depth (feet)	Estimated tonnage	Gold (ounces)	Platinum group (ounces)	Chromite (tons)	Magnetite (tons)
1. 15-20	50 x 10^6	0.7 x 10^6	.07 x 10^6	5 x 10^6	2.5 x 10^6
2. 15-20	100	1.4 x 10^6	.07	10	10
3. 15-	100	1.4 x 10^6	.07	10	10
4. 80-85	70	1.0 x 10^6	.05	2.8	10.5
5. 10-40	50	0.7 x 10^6	.035	2.0	7.5
6. 10-20	50	0.7 x 10^6	.035	2.0	7.5
7. 10	35	0.3 x 10^6	0.015	.7	3.5
Total	455 x 10^6	6.2 x 10^6	0.345 x 10^6	32.5 x 10^6	51.5 x 10^6

Source: Estimates by H. E. Clifton, Geological Survey.

Recent studies by the Geological Survey and University of Oregon have led to the identification of seven deposits on the shelf off southern Oregon at depths ranging from 60 to 480 feet.[6] The best deposits are about 8 miles long and 2 miles wide. Their thickness is unknown but assuming it to average 15 feet, and assuming a mineral concentration similar to that in the nearest onshore black sand, H.E. Clifton has estimated the tonnage of some of the heavy minerals in these deposits as shown in Table 1.

COAL

Uses. Most bituminous coal is burned for heat and power production, or carbonized to produce metallurgical coke. Anthracite coal use falls into two broad categories: 1) as an energy fuel and 2) as a source of industrial carbon. Lignite is used principally as a fuel for residential and industrial heating and for generating electrical power.

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[4] T. P. Thayer, commodity geologist for chromite, Geological Survey, unpublished report, 1968.

[5] A. B. Griggs, "Chromite Bearing Sands of the Southern Part of the Coast of Oregon," Geological Survey Bull. No. 945-E, pp. v, 113-150, 1945.

[6] V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

Present levels of utilization of coal.

World (1966 production)	2.8 billion metric tons, all ranks (2.1 billion tons bituminous coal and anthracite; 700,000 tons lignite)

United States

1966	Short tons	Metric tons
Consumption	486.3	441.1
Production	533.9	484.3
1967 (preliminary)		
Consumption	483.4	438.5
Production	549.0	498.0

Range of demand projections to the year 2000.

Area	1980	1985	2000
United States (million short tons) for U.S. consumption[7]	737[8]	825-850[9]	1,095-1,150[9]
World	3 billion metric tons annually by 1985 (3.3 billion short tons)		

Prospective supplies and prices. U.S. coal reserves are more than adequate to supply all foreseeable demands to and beyond the year 2000, although until the development of economic processes for the reduction of sulfur in coal and the removal of sulfur oxides from stack gases low-sulfur coal will be in relatively tight supply, although generally adequate.

World reserves of coal are estimated at 4,600 billion metric tons, of which approximately 32 per cent are in the United States and 26 per cent in the U.S.S.R. Most of the remaining 42 per cent are in Europe and Asia. On a world-wide basis they are adequate to meet anticipated total requirements far beyond the year 2000.

No information is available on prospective future coal prices either for the world or for the United States. Prices f.o.b. bituminous coal and lignite mines in the United States have remained relatively stable during the past decade ($4.77, $4.58, $4.39, $4.44, and estimated $4.77 in 1959, 1961, 1963, 1965, and 1967, respectively) notwithstanding significant increases in the costs of labor, equipment, supplies, and other cost components. Average transportation costs have declined significantly during the past few years as a result of the introduction and increasing adoption of the unit train concept. As a result of increasing competitive pressures from other energy sources and continuing increases in efficiencies of mining and transportation, it is estimated that delivered coal prices generally will stabilize at or near current levels for the respective qualities of coal and that they will continue at the same relative competitive levels with other energy sources.

Possible substitute materials. Natural gas, petroleum, and atomic energy are competitive with coal as sources of energy.

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[7] Excludes exports and coal for the production of high BTU gas and synthetic liquid fuels from coal when these processes have been developed competitively.

[8] Includes approximately 550 million tons for electric utilities; excludes exports.

[9] Although no official estimates have been made beyond 1980, it is anticipated that coal requirements for power generation will continue steadily upward by 18-20 million tons per year to at least the year 2000, but that the demand for other U.S. consumption combined will stabilize at something near the current levels (185-200 million tons annually). If these estimates hold, requirements will range as shown.

Potential from marine sources. Coal deposits have been mined from the substrate in the continental shelves off Canada, the United Kingdom, Japan, and Taiwan. The mining has been carried out from mine openings located onshore or from shafts in artificial islands. The continental United States is blessed with ample coal deposits but only minor occurrences are known in coastal areas. Except possibly in New England, Oregon, and Washington, formations on land that project out into the continental shelves are generally not coal-bearing and the prospects of finding coal in the shelves is considered poor. In Alaska, coal bearing formations project into the continental shelves in several areas, and the potential for the presence of offshore coal resources is good. However, because the location of the potential resources is remote from markets their economic value is uncertain.

COBALT

Uses. Cobalt has the ability to impart great strength to alloys at high temperatures and magnetic qualities to certain other alloys; these are its two main uses. It is also employed as a nonmetal in pigments, as ground-coat frit, and in salts and driers.

Present levels of utilization of cobalt in million pounds.

World (1966 production)	44.2	
United States (1966 demand)	14.2	(estimated)

Ranges of demand projections to the year 2000.

Area	Projection base		1970	1985	2000
United States	FRB index				
		Low	16.4	29.3	52.0
		High	16.8	34.1	68.6
Rest of World	Time		15.6	22.4	29.1
Total World		Low	32.0	51.7	81.1
		High	32.4	56.5	97.7

Prospective supplies and prices. Much of the cobalt mined is recovered as a by-product of copper or nickel ores. The United States is largely dependent on foreign sources. The major producing countries are Congo, Zambesi, Morocco, and Canada, all except Canada politically unstable.

Cobalt metal sells for $1.85 per pound in the United States; Government-stockpile surplus cobalt sells at a slight discount. World prices are comparable to the U.S. price. Much of the present Congo production is from oxidized materials, but production from the deeper sulfide zone is becoming more significant and may add to the cost of extraction and refining. The probable need for exploration and development of new land-based deposits during the latter part of the projection period suggests that the price of cobalt will rise as much or more than general price increases during this period.

Possible substitute materials. Although nickel is less efficient in some uses it can readily be substituted for cobalt in others without appreciably altering the desired properties. Bismanol magnet alloy, consisting of bismuth, manganese, and powdered iron, or barium ferrite materials, can substitute for cobalt in Alnico magnets. Manganese, lead, and iron can substitute for cobalt in metal driers, but with loss of efficiency.

Potential from marine sources. Cobalt, like copper and nickel, occurs in significant amounts in manganese nodules. If and when manganese nodules are exploited cobalt will doubtless be an important by-product.

No cobalt lode deposits are known in coastal areas of the United States and the possibility of finding lode deposits in the continental shelves is considered very remote.

COPPER

Uses. Copper is one of the most versatile and widely used metals. Its superior electrical conductivity and alloying characteristics are responsible for its importance in the industrial economy. About 50 per cent of all copper consumed is for electrical applications; most of the rest is for alloy manufacture, chiefly brass.

Present levels of utilization of copper in millions of short tons.

World (1966 production)	6.6
United States (1966 demand)	2.4

Range of demand projections in millions of short tons to the year 2000.

Area	Projection base		1970	1985	2000
United States	Gross private business investment				
		Low	2.3	3.6	6.0
		High	2.3	4.2	7.8
Rest of World	Time				
		Low	5.0	7.6	9.7
		High	5.6	9.3	12.8
Total World					
		Low	7.3	11.2	15.7
		High	7.9	13.5	20.6

Prospective supplies and prices. Measured reserves of copper ore in the United States are adequate for domestic demands over the next ten years. However, these reserves represent only the working inventory. The sum of all categories of U.S. reserves are believed sufficient to sustain projected domestic demand until 2000.

World reserves have not been defined as clearly or comprehensively as domestic reserves. However, the rate of new discoveries and the sum of the various classes of reserves–measured, indicated, and inferred–seem to assure an adequate supply of copper to meet world demand until the year 2000. History shows that the grade of copper ore mined has constantly declined as improving technology has made it possible to mine lower grade materials without increase in costs; as a result, reserves have tended to increase. With technology continuing to improve this trend seems likely to continue. No shortage of copper ore seems likely at least for the period of the projections.

Copper prices have been rising recently. Domestic prices have increased steadily from a 1962-63 average of 30.82 cents per pound to an estimated 1967 average of 38.28 cents. This trend is generally expected to extend into 1968, but competition from other materials will exert a growing restraint on each increase. Industry statements suggest that the next several years will see production capacity in excess of demand, with a consequent buildup of stocks that are now depleted.

World prices, in contrast to U.S. prices, fluctuate widely. In 1966, the London Metal Exchange monthly average for spot copper ranged from a low of 51.1 cents per pound to a high of 76.8 cents per pound. In 1967 these averages declined to 45.1 cents before a new series of increases began in May.

Possible substitute materials. Aluminum is the principal substitute material for copper as an electrical conductor. Aluminum wire with a steel core has displaced copper for long-distance transmission lines.

Stainless steel and aluminum have somewhat reduced the use of copper in the building industry. Printed electrical circuits substitute for copper wire and plastic tubing replaces copper in some automotive and appliance uses.

Potential from marine sources. Copper is known to occur in significant amounts in manganese nodules on the Blake Plateau and on the deep sea floor of the Pacific. If and when manganese nodules are exploited, copper will no doubt be an important by-product.

The possibility that lode copper deposits will be found in the continental shelves cannot be ruled out once the exploration technology for locating such deposits becomes available. However, the possibility of lode discoveries must be viewed as rather remote because no large copper deposits are known in onshore coastal areas.

GOLD

Uses. Gold has an outstanding place in the world of metals because of its reflectivity, malleability, high specific gravity, and resistance to corrosion. The principal use at the present time continues to be in monetary systems or in coinage, but its use in other ways is growing. Considerable amounts are used in jewelry and the decorative arts, including watch cases, rings, gold leaf, gilding, gold plating, and decorative finishes on ceramics and other materials. The growth in these uses has paralleled the growth in population and Gross National Product. Substantial amounts are employed in dentistry and lesser amounts in the chemical industry and glass making. It is also being used increasingly in new scientific devices and instrumentation.

Present levels of utilization of gold in ounces.

World (1966 production)	47.0 million
United States (1966 demand; excludes monetary gold)	6.1 million

Ranges of demand projections to the year 2000.

Area	Projection base		1970	1985	2000
United States	GNP				
		Low	6.0	12.0	23.0
		High	6.2	13.5	26.1
Rest of World	Time		43.5	51.7	59.9
Total World					
		Low	49.5	63.7	82.9
		High	49.7	65.2	86.0

Prospective supplies and prices. The land resources are inadequate to supply the projected demands for non-monetary gold for more than a few years at the present price and level of technology. The official world price of gold remained at $35 per fine ounce from 1934 until very recently when an open market for non-monetary gold was established. World production appears to have reached a peak in 1966 and it is expected to decline in coming years, partly as a result of constantly increasing production costs, and partly because of depletion of reserves in the South African gold fields from which presently come 75 per cent of the non-Communist world supplies. It is predicted that the South African source will be largely depleted by about 1990.

United States mine production is only about 30 per cent of consumption and non-monetary demand has been increasing significantly in recent years. Gold in U.S. reserves potentially recoverable at $35 per ounce is approximately equivalent to anticipated consumption through the year 1975. World gold production will be inadequate to balance demand by 1970. World reserves mineable at $35 per ounce are equivalent to projected consumption through 1973 at the present level of technology.

At the beginning of 1966 the world's monetary gold supply was less than 1.2 billion ounces. If this were released for non-monetary uses the overall supply would be adequate to meet 15 to 20 years of projected consumptive demand.

Possible substitute materials. Because of its unique physical properties gold has no satisfactory substitutes. Alloys of the platinum-group metals such as platinum-iridium and palladium-ruthenium are substituted for gold in high-quality jewelry, watchcases, and other decorative articles, their use being determined largely by popular demand and vogue. The various metals and their use in place of gold include platinum and palladium separately or alloyed with gold for various appliances in dentistry; platinum leaf (for gold leaf) for signs and decorative designs; and stainless steel, chromium, and nickel alloys in corrosion-resistant equipment. The quantity of gold displaced by substitution of other materials is small compared with the consumption of gold in the arts and industry.

Geologic potential from marine sources. Of all minerals having a potential for production from submerged placers on the continental shelves of the United States, gold has attracted the most interest. This is based on the occurrence of multimillion dollar onshore placer deposits near the seacoasts of Alaska, California, Oregon, and Washington, and on the presence of known gold deposits in shallow water near shore in several localities.

Since 1899 an estimated $100 to $140 million worth of placer gold has been recovered from the beaches, streams, and coastal plains along the southern margin of the Seward Peninsula.[10] Inasmuch as high values extend to the seashore and production has been achieved both from modern beaches and raised terraces the offshore area appears promising. At least five submerged terraces roughly parallel to shoreline, and a number of submerged river channels perpendicular to shore, formed during the Ice Ages when sea level was several hundred feet lower, have been delineated by the Geological Survey in the Bering Sea at depths ranging from 30 to 400 feet. The most promising prospecting areas should be at intersections of submerged terraces and channels, remnant deposits of glacial till, or local lode sources; these are places where the coarser gold would be expected. Elsewhere the gold is very fine-grained and difficult to recover. At least two private companies, as well as the Geological Survey and Bureau of Mines, have sampled the Norton Sound-Bering Sea area. Preliminary estimates of total potential range from a few million ounces to tens of millions of ounces but much additional sampling and geologic analysis needs to be done before it will be known how much can be recovered with existing technology.

The Gulf of Alaska also has some gold potential, particularly along southeastern Alaska where the largest lode deposits are known on land. As with the Bering Sea, estimates range from millions of ounces to tens of millions of ounces. Much of the fine-grained gold may not be recoverable. Recent reconnaissance investigations by the Geological Survey along the coast of northern California indicate that an area between Crescent City and the Oregon border contains low concentrations of gold as well as platinum and chromite (Table 1). The gold in the Oregon offshore placers is in the range of 10 to 50 cents per ton (0.1 to 0.5 ppm) and in particles less than .005 mg. in mass, too fine-grained for easy recovery.

Several small gold mines occur within 30 to 40 miles of the coast in northern California and southern Oregon and a number of larger mines lie 50 to 75 miles inland.

No gold mines occur within 40 miles of the Atlantic and Gulf coasts and the shelves of these areas are unlikely to contain significant placer deposits.

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[10] E. H. Cobb (compiler), Placer Gold Occurrences in Alaska: U.S.G.S. Mineral Investigations Resource Map MR-38, 1:25,000,000, 1964.

During the last four centuries an estimated $9 million in gold has been recovered from Puerto Rico and some offshore placer gold might be inferred. No specific prospects, however, have been identified. Any offshore deposits are likely to be diluted by biogenous sediments and the prospects for the occurrence of minable deposits are remote.

In summary, the prospects for offshore placer gold look good to excellent in Norton Sound, fair in other parts of the Bering Sea, fair to good off the southeastern coast of Alaska, fair to poor off the coast of Oregon, and poor elsewhere along the coastal United States.

In addition to placer deposits, vein-type lode deposits might be present in the shelf rocks off the coast of Alaska near areas where vein deposits occur onshore. However the exploration technology for finding such deposits has not yet been developed.

IRON

Uses. Iron ore is the basic raw material for iron and steel, the key mineral commodity of industrial civilization. In tonnage, over 90 per cent of all metal consumed in the United States is iron or steel. *Iron,* in a relatively pure state, is a tough malleable metal, but the iron of industry contains several per cent of carbon. *Steel* is a mixture (alloy) of iron and small amounts of carbon. The term *alloy steel* is used to describe mixtures of steel and other elements such as tungsten, nickel, vanadium, chromium and many others. The relatively low price of steel and its versatility makes it the indispensable metal in the U.S. and world economy. The principal users in the United States, in decreasing order of importance are: automotive industry, 19 per cent of total production; construction, 17 per cent; containers, 8 per cent; oil and gas industry, 7 per cent; industrial machinery, 6 per cent; rail transport, 6 per cent; electrical machinery, 3 per cent; appliances, 3 per cent; and agricultural, 2 per cent.

Present levels of utilization of iron in millions of short tons.

World (1966 production)	377.9
United States (1966 demand)	86.5

Ranges of projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Steel production			
	Low	93	115	136
	High	95	121	152
Rest of World	Steel production			
	Low	330	514	701
	High	367	631	914
Total World				
	Low	423	629	837
	High	462	752	1,066

Prospective supplies and prices. Land-based resources in both the United States and in the rest of the world are considered sufficient for well over 100 years. Domestic iron ore prices are based on the Lake Erie price, or price per long ton of ore containing 51.5 per cent iron, at rail of vessel, Lower Lake ports. This published price has remained stable since 1962, except for a reduction of 10 cents per ton on lake freight rates in 1964. Natural ore prices average about $10.70 and pellets are quoted at $10.252 per long ton unit of iron. Since most ore is captive or is sold under long term contracts, the actual cost to the consumer may be less than the quoted price.

Iron ore is traded duty-free in the markets of the non-Communist world. Supplies of high grade iron ore in international trade exceed demand and prices in general depend on negotiated contracts. Recent quotations have been as low as $4 per ton for fines containing 60.5 per cent iron in Oregon and Alaska. However, because of the greater distance of offshore deposits from source rocks the deposits will probably be lower grade and smaller than onshore magnetite sand deposits. In general the outlook is very poor for the recovery of magnetite from offshore placers during the remainder of the 20th century.

Manganese nodules contain upwards of 12 per cent iron but if they are mined the iron might have to be discarded because of metal separation problems.

Bedrock deposits of iron ore do not occur in coastal areas of the conterminous United States, so the prospects for finding such deposits in the continental shelves must be regarded as very poor. In Alaska, large low grade iron deposits are known in the vicinity of Iliamna Lake near Cook Inlet. These may extend offshore. Low grade titaniferous magnetite deposits that extend offshore are known about 30 miles southeast of Juneau.

Hot brines from which iron oxide as well as other metals are precipitating have been found in the deeps of the Red Sea[11] and iron precipitates have been identified from a submarine volcano in Indonesia.[12] No hot spring or volcanic activity that might have given rise to these types of deposits are known around the continental United States or Alaska. However, deposits from ancient volcanos active during Tertiary or Mesozoic times might possibly be sandwiched in with sedimentary rocks in the shelves. The Hawaiian Islands are of volcanic origin but no precipitates of this type have been identified on land there and it is therefore unlikely that they will be found in the shelves.

KYANITE AND SILLIMANITE[13]

The high alumina minerals kyanite and sillimanite (Al_2SiO_5) are commonly present in Pleistocene and recent placer deposits on the Atlantic coast from New Jersey south to the tip of Florida. Tailings from the separation of titanium minerals and zircon from placer concentrates are enriched in kyanite and sillimanite where these minerals are present in the raw sand. Procedures have been developed for the preparation of a 90 to 95 per cent kyanite-sillimanite product from tailings at Florida placers. Resources in onshore placers in Florida are estimated at about four million tons, and the offshore potential is probably considerably less.

MAGNESIUM

Uses. Magnesium is the eighth most abundant element in the earth's crust and the second most abundant element after sodium in sea water. Magnesium metal is used as a structural metal, as an alloying constituent for other metals, and as a reducing agent to produce titanium, zirconium, hafnium, uranium, and beryllium. Since 1956 the metallurgical uses for primary magnesium have exceeded the structural uses, and in 1964 amounted to about 62 per cent of the total use figure. Magnesium as an aluminum alloy accounts for two-thirds of this metallurgical classification.

A wide variety of magnesium compounds are used in the chemical and pharmaceutical industries, and magnesia (magnesium oxide) is used in substantial quantities as a refractory and in the cement, paper pulp, rayon, fertilizer, insulation, and chemical industries. Only magnesium metal is included in the following projections.

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[11] A. K. Miller *et al.*, "Hot Brines and Recent Iron Deposits in Deeps of the Red Sea," *Geochimica et Cosmochimica Acta*, Vol. 30, pp. 341-359, 1966.

[12] K. K. Zelenov, *"O Vozmozhnon Vulkanogennom Istochnike Veschestva Geosink Linalnykh,"* in *Symposium sur les Bauxites* (Zagreb, October 1963), Vol. 1, pp. 115-133, 1964.

[13] W. E. Overstreet, in V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

Present levels of utilization of contained magnesium in thousands of short tons.

World	8,800
United States	2,200

Ranges of demand projection to the year 2000.

Area	Projection base	1970	1985	2000
United States	Steel production			
	Low	2,280	3,060	4,120
	High	2,360	3,560	5,600
Rest of World	Steel production			
	Low	6,900	10,800	14,700
	High	7,700	13,200	18,800
Total World	Steel production			
	Low	9,180	13,860	18,820
	High	10,060	16,760	24,400

Prospective supplies and prices. Resources of raw materials, both land-based and in sea water are virtually unlimited both in the United States and in the rest of the world. Prices of magnesium compounds should remain at present levels indefinitely.

Most magnesium metal in the United States is traded at a discount of 3 to 4 cents a pound under the quoted price of 35-1/4 cents. The world price is 25 to 26 cents a pound. The difference between the domestic and world price appears to be caused by the present import duty rate of 40 per cent.

Possible substitute materials. Aluminum can be used in most structural applications where magnesium is now used. Refractories are made from many materials including bauxite, alumina, zirconia, mullite, silicon carbide, and boron carbide. Depending on requirements, many of these may be used in place of magnesia refractories.

Potential from marine sources. Inasmuch as magnesium is obtained directly from sea water the resource potential is virtually unlimited. Demand and plant capacity will determine how much magnesium is produced from the sea.

MANGANESE

Uses. About 96 per cent of manganese used in the United States is consumed in the metal industries and the rest is used in dry cells and in a variety of chemical industries. Manganese plays an extremely important role in the metallurgical technology of the modern steel age. It is used for pig iron and in a series of ferrous alloys used in steelmaking. The principal alloys are ferromanganese, spiegeleisen, silico-manganese, and silicospiegel. Manganese from these alloys serves to remove free oxygen and sulphur in the melt, increases the strength and hardness of steel, and imparts a mobility that permits the steel to be rolled and forged more easily.

Elemental manganese metal, 99.9 per cent pure, is produced electrolytically from an acid solution of oxide ores. The high purity of this product makes it especially useful for making stainless steel, alloy steels, and manganese alloys of the non-ferrous metals copper, zinc, aluminum, magnesium, nickel, tin, and lead. A relatively small amount of manganese is used in the chemical industry in dry cell batteries, paints, varnishes, ceramics, chemicals, and other items.

Present levels of utilization of contained manganese in thousands of short tons.

World	8,000
United States	1,200

Ranges of demand projections to the year 2000.

Area	**Projection base**	**1970**	**1985**	**2000**
United States	Steel production			
	Low	1,225	1,700	2,265
	High	1,325	1,950	2,900
Rest of World	Time plus world steel production deviations			
	Low	8,000	12,000	16,000
	High	10,000	16,000	21,000
Total World				
	Low	9,225	13,700	18,265
	High	11,325	17,950	23,900

Prospective supplies and prices. Domestic reserves are small and for the most part not competitive with major deposits of the world. Large resources are mostly in developing countries and politically unstable areas.

Domestic price is determined by world price. Low grade domestic resources would require a higher price than the current world price to be minable. Fluctuations in world price will result from changes in ocean freight rates which make up about one-third of the delivered price.

Possible substitute materials. Titanium, zirconium, and rare-earth metals can assume some of the functions of manganese in steel but there are technical limitations to the extent to which they may be interchanged, as well as problems of technology, cost, and supply. A number of dry cells have been developed which do not use manganese and their use is expanding. The chemical and miscellaneous industries offer possibilities for use of other materials in place of manganese and such substitutions are made when costs are favorable.

Potential from marine sources. Manganese nodules, containing nickel, cobalt, copper, and iron, as well as manganese, have been described from several hundred localities, worldwide, on the ocean floor. The most abundant and highest grade nodules occur on the deep ocean floor of the Pacific. They appear to be less common in the Atlantic but a deposit covering 1,800 square miles in 1,500 to 3,000 feet of water[14] is known on the Blake Plateau off the U.S. southeastern seacoast. Manganese stains and crusts are also found in the Gulf of Maine but they are not sufficiently rich and abundant to attract economic interest.

The composition of nodules varies considerably from one locality to another and within a single nodule. Analyses of 54 nodules from the Pacific and preliminary analyses of nodules from the Blake Plateau show this comparison.

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[14] Ocean Science and Engineering, Inc. report to Economic Associates, Inc. and Marine Science Council, October 1967.

	Pacific Ocean[15]	Blake Plateau[16] (averages)
Mn	8.2 - 41.1 per cent	15 per cent
Fe	2.4 - 26.6	11
Co	0.01 - 2.3	0.3
Ni	0.1 - 2.0	0.4
Cu	0.03 - 1.6	0.1

The above figures compare with an average grade of 35-55 per cent manganese being mined from land deposits in various producing countries.

The mineralogic composition of manganese nodules is commonly a mixture manganese-oxide minerals, iron hydroxide, clay minerals, and small amounts of other minerals. Copper, cobalt, nickel and other elements substitute for manganese or iron in the crystal structure of the manganese oxides. It is generally believed that the nodules are formed by precipitation of elements from solution, most likely in colloidal form, and by a process of particle agglomeration.

Goldberg and Arrhenius[17] suggest that the ocean is saturated with manganese and iron and that addition of these two elements by river runoff causes precipitation of hydrated oxides in colloidal form. The colloidal particles are electrically charged and while settling down in water, tend to act as scavengers and remove cobalt, nickel, copper, molybdenum, zinc, lead, and other metals from sea water. Small particles of detrital minerals and organic debris settling through water could act as centers of accretion and would be effective in extracting manganese and other metals from the water.

When the colloidal particles reach the seafloor they are attracted to any protruding objects such as rock fragments because such objects act as superior electric conductors in attracting the electrically charged colloidal particles. Bottom currents carry a new supply of water bearing the colloids to the nucleus and the nodules are in this way enlarged layer by layer by this process of particle agglomeration. As long as a nodule is exposed on the sea floor it can continue to grow but once buried beneath sea floor sediments it will stop growing.

The rate of growth of nodules on the deep sea floor has been estimated from observational data and radiometric observations as on the order of 0.01 to 1.0 millimeter per 1,000 years. However, nodules occurring locally on continental slope areas close to continents may form more rapidly—perhaps at the rate of 0.01 to 1.0 millimeter per year.[18]

There seems to be no doubt that the gross amounts of manganese nodules on the seafloor are enormous. However it is the belief of most people in the mining business that the economic potential is highly uncertain owing to: 1) the low grade compared to land sources; 2) difficulty in recovering the nodules in thousands of feet of water, and 3) problems of extracting the individual fine-grained metal components. Even a major breakthrough in extractive metallurgical processes might not be the answer as it would bring large quantities of low grade manganese ore on land into competition with sea floor nodules. It may well develop that when manganese nodule deposits are worked it will be for their by-product metals cobalt, nickel, and copper and not for their manganese.

The general outlook for manganese nodule mining is considered poor until the 1980-85 period and after that fair.

Although interest in manganese from marine sources is chiefly focused on nodules, it has been pointed out by McKelvey and Chase[19] that marine sediments hold a potential for thick high-grade deposits of manganese oxides or carbonates associated with submarine hot springs or volcanic exhalations. Manganese precipitates have been identified from a submarine volcano in Indonesia[20] and hot brines are precipitating manganese oxide in the deeps of the Red Sea. No hot spring or volcanic activity that may have given rise to this type of deposit is known around the continental United States or Alaska. However deposits from ancient volcanos active during Tertiary or Mesozoic times might possibly be sandwiched in with sedimentary rocks in the shelves. The Hawaiian Islands are of volcanic origin but no hot spring or other manganese precipitates are known on land, and it is therefore unlikely that they will be found offshore.

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[15] John L. Mero, *The Mineral Resources of the Sea* (New York: Elsevier, 1965).

[16] F. T. Manheim and R. M. Pratt, Summary of Investigations Conducted in 1967, Woods Hole Oceanographic Institution Ref. No. 68-32 (unpublished paper).

[17] E. D. Goldberg and G. Arrhenius, "Chemistry of Pacific Pelagic Sediments," *Geochimica et Cosmochimica Acta*, Vol. 13, 1958.

[18] F. T. Manheim, in "Mineral Facts and Problems," Bureau of Mines Bull. No. 630, 1965.

[19] V. E. McKelvey and Livingston Chase, "Selecting Areas Favorable for Subsea Prospecting," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966), pp. 44-60.

NICKEL

Uses. Nickel, a hard, silvery white metal, has, besides its use in coinage, multiple industrial uses as an alloy with other metals. The principal use is in ferrous alloys but nickel is also combined with other metals, especially copper and chromium. To a lesser extent uncombined metallic nickel is used for electroplating and in certain kinds of storage batteries. In powder form it has many applications in the chemical and electronic industries.

Present levels of utilization of nickel in thousands of short tons.

World (1966 production)	475
United States (1966 demand)	197.5

Ranges of demand projections to the year 2000.

Area	Projection base		1970	1985	2000
United States	FRB index				
		Low	199	356	632
		High	204	414	833
Rest of World	Time		377	604	832
Total World					
		Low	576	960	1,464
		High	581	1,018	1,665

Prospective supplies and prices. Although nickel is expected to be in short supply in the near future, the long term outlook is for adequate supplies from widely distributed large reserves. Canada, New Caledonia, U.S.S.R., and Cuba have large nickel resources.

The current domestic price for nickel in large lots is 94-96 cents per pound for metal; nickel oxide sinter and ferronickel are slightly cheaper. A small amount of nickel marketed by dealers sells at a premium. Future prospects are for a steady price and adequate supplies from foreign sources. The world price is approximately the same as the U.S. domestic price .

Possible substitute materials. High-nickel alloys can be replaced substantially by nickel-chromium-molybdenum steels, boron-bearing steels, chromium-manganese-nickel stainless steels, and nickel-free stainless steels. More extensive use could be made of iron-base alloys and iron-chromium-aluminum alloys in electrical resistors. Nickel-plated and nickel-clad products can be used where only surface protection is needed.

Potential from marine sources. Nickel is one of the important constituents of manganese nodules. If and when nodules are recovered from the deep sea floor nickel will be either the metal of principal interest or an important by-product. The dearth of nickel lode deposits in the United States makes it very unlikely that lode-type deposits will be found in the continental shelves.

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[20] Zelenov.

PHOSPHATE

Uses. About 70 per cent of the world's production of phosphate rock is used in the production of fertilizer. Phosphorus has many other uses in industry. A few of the more important are in the manufacture of detergents and soaps, animal feed supplements, baking powders, metallurgical alloys, water softening agents, petroleum refining agents and additives, drugs, and military devices including incendiary bombs and smoke screens.

Present levels of utilization of phosphorous content (phosphate rock) in thousands of short tons.

World (estimated from production)	12,770
United States	3,740 apparent demand (actual consumption estimated to be about 500,000 tons less)

Range of demand projections to the year 2000 for phosphorous materials.

Area	Projection base		1970	1985	2000
United States	GNP and population				
		Low	3,200	4,700	7,000
		High	5,000	7,800	15,000
Rest of World	GP and population				
		Low	9,000	19,000	33,000
		High	11,500	27,000	56,000
Total World					
		Low	12,200	23,700	40,000
		High	15,500	34,800	71,000

Prospective supplies and prices. Resources in the United States are very large. World resources are also very large and no overall shortage of supplies is anticipated through the year 2000. However many developing countries that badly need phosphatic fertilizers to increase food production are totally lacking in phosphate resources.

Prices of phosphate rock are based on the tricalcium phosphate (bone phosphate of lime, B.P.L.) content in per cent.[21] Prices are quoted per long ton for Florida land-pebble phosphate rock only, but these can be used as a guide to prices of rock from the United States areas and in world trade. The grade ranges from 66 to about 78 per cent B.P.L. and the prices from $6.50 to $10.20 per short ton. Much of the phosphate is sold on contract, the price being subject to negotiation. No significant change in price is expected through 1985. It is possible that the domestic price may increase after 1985 when it appears that higher production cost deposits will need to be exploited.

Possible substitute materials. Phosphorus has no substitute as a plant-food element. Basic slag, a by-product of bessemer or basic open hearth steel manufacturing is, however, an important source of agricultural phosphorus in countries that are deficient in deposits of phosphate rock. Guano and bone meal are also used for their phosphorus content.

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[21] Tricalcium phosphate (B.P.L.) contains about 20 per cent phosphorous.

Phosphorus compounds used in products other than fertilizers, such as foods, synthetic detergents, and fire extinguisher compounds, can be replaced by other materials at a sacrifice of quality or at increased cost.

Potential from marine sources. The solubility of phosphate in sea water increases with decreasing pH and temperature.[22] For this reason it is concentrated in deep cold waters. Phosphorite nodules are formed in areas of upwelling water where the cold waters from depth, containing relatively high concentrations of phosphate (as well as a high concentration of nutrients) are brought near the surface, thus increasing their pH and temperature and causing phosphate to precipitate either inorganically or biochemically in the form of apatite.[23] The areas of upwelling are generally characterized by desert areas of low rainfall on adjacent lands and by the absence of large rivers, factors that result in a relatively small amount of detrital sediment in the ocean.[24] This condition favors the development of phosphorite nodules.

Offshore banks that provide topographic isolation from detrital sediments are especially favorable places to look for phosphorite nodules if they are also in areas of upwelling. Figure 1 shows the known and probable distribution of phosphorite off southern California. Note the association with topographic highs. Figure 2 shows the worldwide distribution of upwelling water, phosphate deposits, and related phenomena. As the map indicates, the areas of upwelling and areas of known phosphorite nodule deposits are mostly along the western margins of continents. The largest nodule deposit off the coast of the United States is off southern California where Emery[25] has estimated over one billion tons. According to Mero,[26] not more than 100 million tons of this deposit is economic grade. Most of it is in water less than 1,800 feet deep. These figures include only nodules lying on the surface. The nodules contain up to a maximum of 29 per cent P_2O_5 compared with land-based phosphate ore that generally

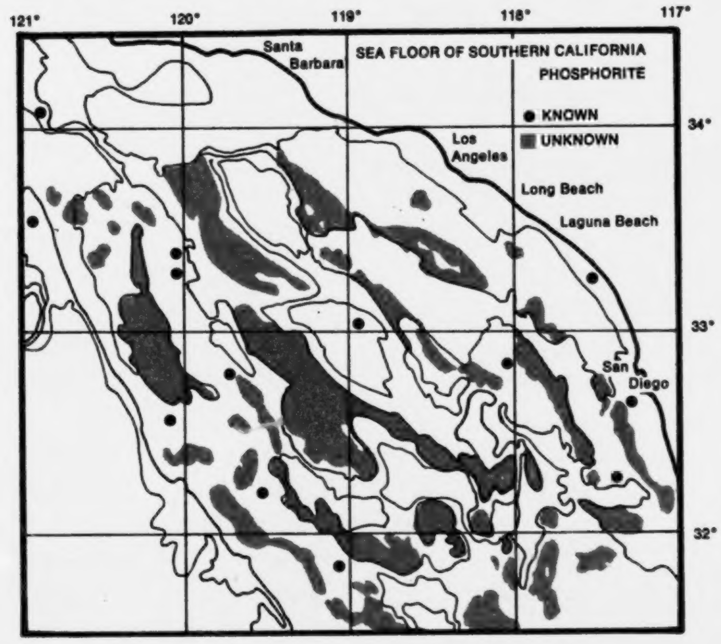

Figure 1. *Distribution of phosphorite off southern California. Source: K.O. Emery,* The Sea off Southern California: A Modern Habitat of Petroleum *(New York: John Wiley & Sons, Inc., 1960).*

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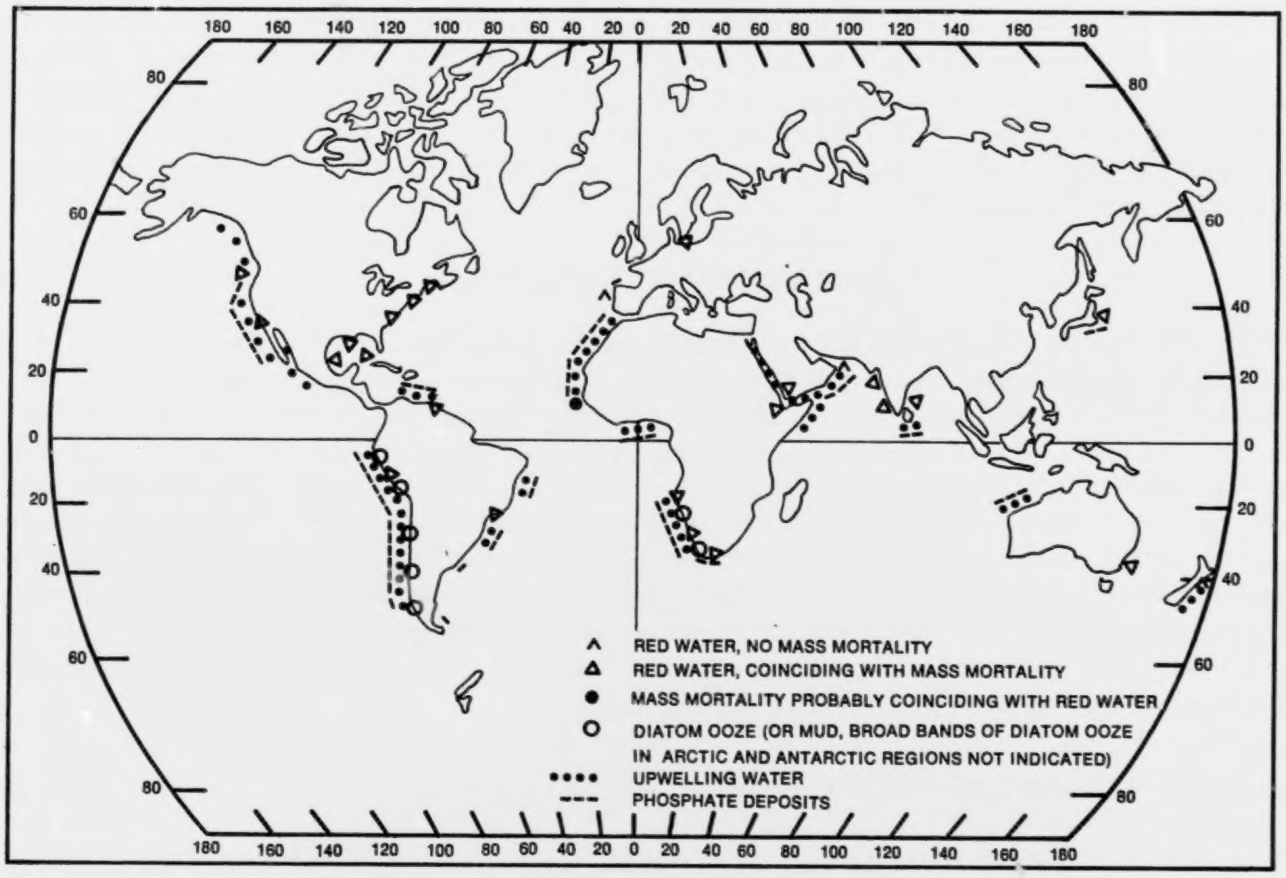
[22] H. U. Svendrup *et al.*, "Research Within Physical Oceanography and Submarine Geology at the Scripps Institution of Oceanography During April 1945 to April 1946," *American Geophysical Union Transactions*, Vol. 27, No. 4, pp. 571-573, August 1946.

[23] V. E. McKelvey and Livingston Chase, "Selecting Areas Favorable for Subsea Prospecting," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966).

[24] K. O. Emery, "Geological Methods for Locating Mineral Deposits on the Ocean Floor," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966), p. 32.

[25] K. O. Emery, *The Sea off Southern California: A Modern Habitat of Petroleum* (New York: John Wiley & Sons, Inc., 1960).

[26] John L. Mero, *The Mineral Resources of the Sea* (New York: Elsevier, 1965).


180 160 140 120 100 80 60 40 20 0 20 40 60 80 100 120 140 160 180
80
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0
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80
^ RED WATER, NO MASS MORTALITY
Δ RED WATER, COINCIDING WITH MASS MORTALITY
● MASS MORTALITY PROBABLY COINCIDING WITH RED WATER
O DIATOM OOZE (OR MUD, BROAD BANDS OF DIATOM OOZE IN ARCTIC AND ANTARCTIC REGIONS NOT INDICATED)
•••• UPWELLING WATER
--- PHOSPHATE DEPOSITS

Figure 2. *Distribution of upwelling water and related phenomena in modern oceans (modified Brongersma-Sanders, 1957, to include data on the distribution of phosphate deposits). Source: V.E. McKelvey and Livingston Chase, "Selecting Areas Favorable for Subsea Prospecting," in* Exploiting the Ocean *(Washington, D.C. 20005: Marine Technology Society, 1966).*

averages over 31 per cent. Phosphate for fertilizer manufacture must contain a minimum of 31 per cent P_2O_5 and if it contains less than that it must be beneficiated, a process that is difficult when the phosphatic nodules or pellets contain less than that amount. Collier Carbon and Chemical Company attempted to recover nodules from a deposit on Coronado Bank in this area in the early 1960's but was forced to abandon it because of the presence of an associated naval ordnance dump.

Phosphorite nodules and slabs are also found off the Atlantic coast in waters 600-1,600 feet deep. They are most abundant and richest on the .1 degree slope extending from the outer edge of the Continental Shelf off Florida down to the Blake Plateau.[27] These contain on the order of 20 per cent P_2O_5. Phosphorite nodules also occur on the upper thousand feet of the continental slope as far north as New York, but the nodule concentrations seem to decrease markedly in a northward direction.

In addition to phosphorite nodules, three other types of marine phosphatic deposits are known: phosphatic sands, pelletal phosphatic muds, and consolidated phosphatic beds of Tertiary age. Phosphatic sands occur up to 75 miles off the coasts of Georgia and the Carolinas in water depths ranging up to 600 feet and in concentrations of one to eight per cent P_2O_5.[28] An area of relatively high concentration 10 miles long and three to four miles wide lies in 60 to 100 feet of water about 10 miles off Cape Fear. This deposit may contain four million tons of P_2O_5 at an average concentration of 4 to 6 per cent.[29]

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[27] K. O. Emery, "Some Potential Mineral Resources of the Atlantic Continental Margin," in *Geological Survey Research 1965,* Geological Survey Professor Paper 525-C, pp. C-157-C160, 1965.

[28] D. R. Peaver and O. H. Pilkey, "Phosphorite in Georgia Continental Shelf Sediments," *Geology Society of America Bulletin,* Vol. 77, No. 8, pp. 849-858, 1966.

[29] Ocean Science and Engineering, Inc. report.

Until now, sea shore phosphorite deposits have been rejected as economical sources of P_2O_5. It seems debatable whether submarine phosphorite can be mined economically in close competition with land deposits. However for coastal areas such as California and Chile that do not have land deposits those offshore should be valuable. The critical question, as always with low value deposits, is not whether submarine phosphate can be produced for the world market but whether it can compete with world sources in the local market.[30]

PLATINUM GROUP METALS

Uses. Metals of the platinum group include platinum, palladium, iridium, osmium, rhodium, and ruthenium. All these metals are essential in modern industry and are among the strategic and critical materials held in the national stockpile. The uses of platinum and its alloys are based on their resistance to corrosion, heat, and oxidation; electrical conductivity; and superior catalytic properties. Major uses include catalysts in the production of high-octane gasoline and various chemicals such as sulphuric acid; and alloys for jewelry, dentistry, and electrical apparatus. Platinum is also used in laboratory apparatus and ware, in equipment used in the manufacture of glass and synthetic fibers, and in certain delicate sensing instruments. Palladium has uses similar to platinum and is also used in electrical contacts and in nonmagnetic watches. The other metals of this group are used principally to improve the hardness and other properties of platinum and palladium. Osmium and ruthenium are used in hard alloys for fountain pen tips, phonograph needles, and fine machine bearings.

Present levels of utilization of platinum group metals in troy ounces.

World (1966 production)	2,950,000
United States (1966 sales to consuming industries)	1,675,795

Ranges of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	FRB index			
	Low	1,789,000	3,664,000	6,958,000
	High	1,839,000	4,361,000	9,365,000
Rest of World	Steel production			
	Low	1,714,000	3,154,000	4,306,000
	High	2,002,000	4,075,000	6,033,000
Total World				
	Low	3,503,000	6,818,000	11,264,000
	High	3,841,000	8,436,000	15,398,000

Prospective supplies and prices. U.S. resources are virtually nil; most of the platinum group metals produced to date in the United States were by-products of gold placer mining.

World resources are mostly in the U.S.S.R. and South Africa. They are relatively large and probably adequate for many years of production at or near current amounts and price levels. Adequate future supply and price stability will depend on rapid expansion of production and consistent marketing prices. However many problems must be overcome if output is to be significantly increased over present levels. Restriction of major resources to a few areas in the world is a significant factor in the development of this group of special-use metals.

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[30] V. E. McKelvey and Livingston Chase, "Selecting Areas Favorable for Subsea Prospecting," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966).

Prices are expected to remain firm into the foreseeable future. Most metals are sold by producers but a part of sales are handled by dealers. Current prices are: platinum, $109-112 per troy ounce (dealers' price $210-220); palladium, $37-39 (dealers' price $39-40); iridium, $185-190 (dealers' price $205); osmium, $300-450 (nominal); rhodium, $220-225 (dealers' price $258-260); and ruthenium, $35-60.

Possible substitute materials. The high price of the platinum group metals exposes their field of use to inroads by substitutes and it restricts the expansion of their use. There is considerable substitution within the group itself, as well as alloying with metals of the group to increase hardness or strength. Nickel alloy wire is used for resistors instead of platinum wire where extreme stability is not required. Tungsten competes with platinum and palladium for use as electrical contacts where arcing occurs. Cladding with platinum-group metals is a form of substitution where reliance is put on cheaper metals for mechanical strength and upon the noble metal for surface properties. In the field of catalysis nickel boride and the oxides of nickel and cobalt compete for use in fuel cells. The life of platinum reforming catalysts in petroleum refining is extended by treating the reformed distillate with a nickel catalyst. Vanadium is used in place of platinum in making sulphuric acid.

Potential from marine sources.[31] Platinum has been produced in the United States from one placer area at Goodnews Bay, Alaska and as a by-product in the mining and refining of other metals, notably gold. Although the Goodnews Bay deposits lie very close to the sea, the area offshore has apparently been covered by about 200 feet of glacial debris and any deposit would lie beneath this thick blanket of overburden.

Total production at Goodnews Bay is estimated at three to six million ounces. Present knowledge of the regional geology of the area indicates that it would be unreasonable to infer the presence of more than 50,000 ounces in concentrated deposits offshore. There is little possibility that a deposit this size would support mining costs, and until some economic means can be found to mine through 200 feet of overburden it is unlikely that significant quantities of platinum will be mined in the Alaska area.

Platinum also occurs in beach sands elsewhere in Alaska and along the coast of California but the deposits are so small that it is doubtful the areas are worthy of consideration. The outlook for offshore platinum mining looks poor over the remainder of the 20th century.

OYSTER SHELL AND CALCIUM CARBONATE MATERIALS

Uses. These materials are essentially limestone and the principal uses are the same as for limestone. Limestone is one of the few raw materials that are absolutely basic in modern industry and necessary to our modern civilization. Major uses are in the manufacture of portland cement and as a source of lime, for which there are over 7,000 requirements. Most of these uses depend on the caustic properties of calcium oxide or calcium-magnesium oxide. In some cases it serves to combine with and remove unwanted materials from a desired product as in the manufacture of steel and the refining of sugar or petroleum. Many of the uses of limestone are almost as old as recorded history.

Prospective supplies and prices. Gross resources of calcium carbonate raw materials, both on land and beneath the sea, are virtually unlimited in the United States and in the world. Locally, however, resources may be sparse or totally lacking, particularly for higher quality raw materials for chemical or metallurgical use.

In the United States oyster shell has reported value of $1.50 per ton f.o.b. dredge; crushed limestone is valued at $1.35 per ton f.o.b. quarry. Actual delivered prices at use site may be much higher depending upon factors such as distance from production plant and competition in the local market. Typical prices for crushed stone in metropolitan areas average about $2.75 per ton. World prices vary locally and are generally assumed to be in proportion to the local stage of economic development and per capita wealth.

Possible substitute materials. Limestone, marble, chalk, calcareous marl, and dolomite as well as shells and calcium carbonate "mud" are materials that are used as a source of the various lime products.

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[31] Summarized largely from Ocean Science and Engineering, Inc. report.

Present levels of utilization of all forms of calcium carbonate in millions of short tons.

World (1966 production)	4,000 (estimated)
United States (1966 demand)	595 (21 million tons of oyster shell was produced in 1965 in United States)

Ranges of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Resident population			
	Low	610	890	1,180
	High	640	1,100	1,580
Rest of World	Steel production			
	Low	3,900	6,000	7,800
	High	4,300	7,400	10,300
Total World				
	Low	4,510	6,890	8,980
	High	4,940	8,500	11,880

Potential from marine sources.[32] Land resources of calcium carbonate rocks are so abundant and widespread that no serious attempt has even been made to determine reserves.[33] However, the land sources are by no means evenly distributed, and some large urban areas have no nearby land source. Owing to the high cost of transporting calcium carbonate materials from distant land sources, expanding urban areas located in coastal areas have looked to the sea for an alternate source of supply. Potential materials are oyster shells, calcareous rocks such as coral, calcareous sands and calcareous ooze.

During 1966 about 20 million tons of oyster shell were produced from the sea floor adjacent to the United States. Most of this came from Texas and other Gulf Coast states but large amounts were recovered from San Francisco Bay and lesser amounts from areas off Maryland, Virginia, and Pennsylvania. All the shell deposits mined along the U.S. coast have been located in sheltered bays and lagoons. They are generally covered by overburden and may be as much as 25 feet thick.[34] The size and location of reserves are considered local trade secrets. Deposits of oyster shell are probably also present offshore but they may be smaller than those in bays and lagoons. A minimum of 100 million tons of shell may lie on the Continental Shelf off the Gulf coast.

Calcareous reefs and sands are common along the coasts of southern Florida, Puerto Rico, the Virgin Islands, and the Hawaiian Islands. Only the Hawaiian Islands of these four areas has a shortage of readily available calcium carbonate deposits on land. However, the cheapness of sea transportation relative to land transportation could make importation of, for example, Florida calcium carbonates attractive in some cases to fairly distant consumers.

Little information is available on calcareous sand reserves off the Hawaiian Islands. However, the high cost of calcareous sand from land based sources in Hawaii (nearly $4 per cubic yard) favors the initiation of offshore recovery from lagoonal sands and muds and from coral reefs.

Calcareous ooze is fairly common in the Florida-Puerto Rico area and is believed to have a fair potential because it is relatively easy to recover.

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[32] *Ibid.*

[33] P. G. Cotter, "Lime and Calcium," in *Mineral Facts and Problems,* Bureau of Mines Bull. No. 630, 1965.

[34] Mero.

POTASH

Uses. Potash is a term that means potassium oxide but it is used widely to denote several other potassium salts as well. It is an essential ingredient of fertilizers and about 94 per cent of the potash used in the United States is for agricultural purposes. The remaining 6 per cent is consumed by the chemical industry. The major potash-chemical-consuming industries include detergents and soap, glass and ceramics, textiles and dyes, and chemicals and drugs.

Present levels of utilization of potash materials in short tons.

World	13,371 (potassium content)
United States	3,320 (potassium content)

Range of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	GNP and population (modified)			
	Low	3,400	4,800	6,600
	High	4,000	7,800	15,000
Rest of World	GNP and population (modified)			
	Low	11,550	21,000	34,000
	High	13,000	23,500	45,000
Total World				
	Low	14,950	25,800	40,600
	High	17,000	31,300	60,000

Prospective supplies and prices. United States potash reserves are estimated to be about 400 million tons or more than 100 years of supply at the present rate of consumption. World reserves, chiefly in Canada, Germany, and the U.S.S.R., are more than 60 billion tons, or several thousand years supply at the present rate of consumption. However, the deposits are not evenly distributed throughout the world and many countries must import all their requirements.

Prices for potassium compounds are quoted on the short-ton unit (1 per cent, or 20 pounds K_2O per ton) and f.o.b. the mine. Bulk prices for New Mexico standard grade muriate (potassium chloride), 60 per cent K_2O minimum, in the crop year 1963-1964 ranged from 35 to 40 cents per unit for standard grade. At present an oversupply of potash exists and prices are below normal. A small increase may be expected about 1974 or 1975, but not above the 1965 price of about 36 cents per unit K_2O for standard grade muriate. No further significant price increases are anticipated through 1985.

Possible substitute materials. There is no substitute for potassium compounds in agriculture. They are not only necessary for plant growth but regulate the intake by plants of the other minerals and elements needed for normal plant growth. Some sodium compounds might be used in place of potassium compounds in certain chemical applications if the need arose.

Potential from marine sources. During World War I the United States became desperately short of potash and plants were set up to obtain it from about a dozen uncommon sources, one of which was seaweed.[35]

The California kelp (Macrocystis) reportedly supplied up to 10 per cent of U.S. requirements from 190,000 tons harvested between 1916 and 1920.[36] Kelp, upon drying, loses 75 to 85 per cent of its weight, and dried kelp contains the equivalent of about 25 per cent potassium chloride or 16 per cent potassium oxide (K_2O equivalent).[37] Only the giant kelp is present in sufficient quantity to be a potential source for potash.

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[35] R. W. Lewis, "Potassium," in *Mineral Facts and Problems,* Bureau of Mines Bull. No. 630, 1965.

[36] Department of the Interior, *U.S.G.S. Yearbook, 1916* to *1920.*

Sea water contains about 380 parts per million potassium (Table 6, Mineral Resources and Ocean Mining) making this element one of the more abundant constituents. Although this may be regarded as a virtually limitless potential resource, the extremely large high grade land-based potash resources make it very unlikely that it will be economically feasible to recover potash from sea water for a long time.

The sedimentary rocks in the Gulf Coast shelves are also a possible source of potash because of the presence of large salt deposits; however, none is known for certain.

McKelvey[38] points out that saline deposits at shallow depths in areas of upwelling are another possible source of potash, although it has not yet been found offshore.

RARE-EARTH ELEMENTS

Uses. The uses of rare-earth elements, as compounds, metals, and alloys, may be grouped in the following categories listed by order of importance: the glass industry; carbons for arc lighting; metals and alloys; and miscellaneous applications.

Present levels of utilization of rare-earth oxide equivalents in tons.

World, exclusive of United States (1966 production)	6,500
United States (1966 demand)	5,700

U.S. production must be withheld to avoid disclosing individual confidential data.

Ranges of demand projections to the year 2000.

Area	Projection base		1970	1985 (Short tons REO)	2000
United States	GNP				
		Low	6,600	12,000	20,000
		High	7,000	13,000	24,000
Rest of World	GP				
		Low	2,350	4,400	8,300
		High	2,360	4,600	8,900
Total World					
		Low	8,950	16,400	28,300
		High	9,360	17,600	32,900

Prospective supplies and prices. Until recently, domestic production of the rare-earth elements was obtained from monazite, largely imported. The bastnaesite deposit at Mountain Pass, California, assures a domestic supply of most of the rare-earth elements through year 2000 and many years beyond at average prices approximating those currently in effect. Prices can show violent surges if large-scale uses for individual rare-earth elements develop without concomitant increasing demand for the other 14 members of the group. Some low-grade resources, such as those in phosphate rock, would come into production if prices showed an inclination to stiffen appreciably.

Thorium is a by-product of monazite processing and a strong demand for it could create a surplus of rare-earth elements with a consequent lowering of rare-earth prices.

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[37] Ocean Science and Engineering, Inc. report.

[38] V. E. McKelvey and Livingston Chase, "Selecting Areas Favorable for Subsea Prospecting," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966).

Possible substitute materials. Substitutes are available for many of the applications of the rare-earth elements. Rare-earth oxides, arsenic, and selenium are partly interchangeable for decolorizing glass but rare-earth compounds have no substitutes in the production of special glasses for absorption of the ultraviolet or yellow portions of the light spectrum. In carbon-arc electrodes, rare-earth compounds are far superior to any other material.

Potential from marine sources. The rare earths include 15 chemically similar elements. They are concentrated in monazite (discussed under thorium), xenotime, allanite, apatite, and bastnaesite. Xenotime occurs commonly with monazite but is much less abundant. Allanite is not a hard chemically resistant mineral so it rarely finds its way into placer-type deposits from parent granitic and metamorphic rocks in which it is sparsely distributed.

Apatite, the principal phosphate-bearing mineral in phosphorite nodules, may contain significant quantities of rare earth elements. However the rare earth concentrations in apatite are not sufficient to brighten the future of the offshore mining of phosphatic nodules.

A major source of rare earths is a deposit containing bastnaesite in southeastern California where reserves are reported to contain four to five million tons. At the 1966 rate of U.S. demand (5,700 tons) this supply would suffice for 600 to 800 years. If demand for rare earths were to increase suddenly or recovery technology to advance, on shore phosphate mines might become an important source.

Procurement of rare earths from the sea floor seems limited at present to monazite recovery, which is tied closely with black sand mining.

SALT

Uses. The largest users of salt in the United States are the chemical industries, which consume about 65 per cent. The manufacturers of chlorine and its coproduct sodium hydroxide consume about 39 per cent of national production; manufacturers of soda ash consume about 21 per cent; all other chemical users consume 4 to 5 per cent. Salt is also used in fairly large and growing amounts on roads to melt ice and snow, in water softeners, and in the growing and processing of food. Table salt accounts for about 3 per cent of salt usage.

Present levels of utilization of salt in million short tons.

World (1966 production)	122.5
United States (1966 demand)	36.5

Ranges of demand projection to the year 2000.

Area	Projection base	1970	1985	2000
United States	FRB Index			
	Low	43.5	79	141
	High	44.4	92	187
Rest of World	Population			
	Low	98	161	243
	High	100	171	268
Total World				
	Low	142	240	384
	High	144	263	455

Prospective supplies and prices. Supplies of salt in the form of natural and artificial brines and rock salt are more than adequate to meet present and future domestic demands at low cost. The rest of the world has numerous salt deposits that are minable at costs comparable to those in the United States if modern mining methods are employed. Developing nations will probably continue to produce solar salt from the sea for minimal usage.

Salt prices are quoted at $1.00 per hundredweight for rock salt in paper bags and in carlots f.o.b. New York and $1.34 per hundredweight for table salt on the same basis.

Potential from marine sources. Enormous tonnages of salt are available on land and from offshore salt domes. The total number of domes now known on land and offshore in the Gulf Coast area is well over 300. There also exists the probability of bedded salt deposits in the continental shelves of the Gulf Coast. In addition, salt can be extracted from sea water. The potential for salt from marine sources is therefore virtually unlimited, but in view of huge land-based resources available it is unlikely that salt will be extracted from marine sources other than sea water for a long time.

SAND AND GRAVEL

Uses. About 96 per cent of sand and gravel utilization is in concrete for construction of buildings and for concrete and bituminous paving. The glass industry is an important user of higher quality sands, and large tonnages of sand are used in iron and steel foundries to make molds for steel castings. Smaller amounts are used for ceramics, in stone sawing, sand blasting, glass grinding, stone polishing, as fillings in paints, plasters, and cements, and as an abrasive material in soaps and polishing compounds. Sand is also used in the chemical industry and as a filter in municipal water plants.

Present levels of utilization of sand and gravel in millions of tons.

World (1966 production)	6,534 (estimated)
United States	933

Ranges of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Resident population			
	Low	950	1,390	1,870
	High	980	1,670	2,530
Rest of World	Steel production			
	Low	6,400	9,900	12,700
	High	7,100	12,200	17,000
Total World				
	Low	7,350	11,290	14,570
	High	8,080	13,870	19,530

Prospective supplies and prices. Resources of sand and gravel, both on land and beneath the sea, are virtually unlimited in the United States and in the world. However, shortages may exist locally, especially in urbanized or heavily populated areas.

Sand and gravel in the United States is valued at an average of $0.99 per ton f.o.b. pit for use as construction aggregates. Actual delivered prices are much higher, depending upon factors such as distance from production site and competition in the local market. Typical prices in metropolitan areas vary from about $1.30 to $4.00 per ton and average about $2.00 per ton. World prices vary locally and are generally assumed to be in proportion to the local stage of economic development and per capita wealth.

Possible substitute materials. Crushed stone, iron-blast-furnace slag, and fly ash are used to supplement or replace sand and gravel in some types of construction. Stone sand produced by marble and granite processors is frequently used to replace natural sand in masonry work and larger sized chips from the same processors find a ready market for exposed aggregate panels. Light-weight aggregates made from shale or clay are used in some types of concrete blocks.

Potential from marine sources.[39] Sand and gravel, though lacking in glamour, nevertheless represent the most widely exploited resource from the surface of the continental shelves (Table 5, Mineral Resources). Although land-based resources are very widespread, many coastal urban areas are experiencing an aggregate shortage due to suburban expansion, the increasingly high cost of real estate, and high transportation costs. This shortage has resulted in a marked rise in price in such urban areas as Los Angeles, New York, and Honolulu.

Since the demand for sand and gravel is largely centered along the coastlines the potential market for offshore sand and gravel is quite large. Because sea transportation costs are much lower than land transportation costs it will be economically feasible for source areas and markets to be separated by distances much greater than those now feasible for conventional sand and gravel operations. Another advantage is that it is much easier to classify sands and gravels at sea where disposal of water and excess fines can be done with minimum difficulty.

The continental shelves are primarily depositional areas and large areas are covered by deposits of sand, gravel, and clay. In many areas the sands extend nearly continuously from the beaches to depths of 600 feet at the shelf edge, usually a distance of many miles. Much of the sand and gravel on the Atlantic shelf was deposited during Pleistocene time when the sea level stood several hundred feet lower and when melting ice sheets that covered the northern third of the United States were discharging vast quantities of sand and gravel.

It has been estimated that sand deposits cover about 50,000 square miles of the Atlantic shelf and areas about half as large off the Gulf and Pacific coasts. Some deposits exceed 180 feet in thickness.[40] The shelf sands are mostly well sorted, and deposits of various grain sizes can often be found within a 100 square mile area. Sand suitable for most requirements can probably be found at one place or another on the continental shelves. The reserves of sand on the shelves are huge and could probably supply demands for many centuries.

Gravel is not as abundant on the shelf as sand and is commonly covered by sand overburden, but surface gravel layers in some areas are fairly extensive. One widespread gravel layer lies just off New York City and another covers a large part of Georges Bank.[41] Gravel beds 20-40 feet or more thick can also be expected to fill buried river channels that were cut in the shelf during the Pleistocene period of lower sea level. These submerged deposits may contain upwards of 100 million tons each but unfortunately the known ones are covered by sand 40 to 150 feet thick and exploitation may not be feasible unless the sand can also be marketed.

It appears that an offshore sand and gravel industry, still in its infancy, will grow rapidly and develop to substantial size within the next 10 years in some areas. This is based on rising demand; abundance of suitable deposits in shallow water near markets; relative ease with which materials can be recovered, classified, and transported; and possible multiple benefits that might include deepening and widening navigation channels, reducing tidal current speeds, increased mooring areas, and other such factors.

STAUROLITE[42]

Staurolite has been separated from placer concentrates in Florida and South Carolina for use as a blending agent in the manufacture of portland cement and as a premium grade product for sand blasting. Any concentrates from placers along the east coast of the United States, including offshore, will probably have some staurolite, which must be removed when separates are made of the titanium minerals, zircon, and monazite. Offshore resources would probably be a significant fraction of the estimated seven million tons of onshore resources, located mainly in Florida.

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[39] Summarized largely from Ocean Science and Engineering, Inc. report.

[40] K. O. Emery, "Geological Methods for Locating Mineral Deposits on the Ocean Floor," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966).

[41] *Ibid.;* John Schlee, "New Jersey Offshore Gravel Deposit," *Pit and Quarry,* Vol. 57, No. 6, pp. 80-81, 1964.

[42] W. C. Overstreet, in V. E. McKelvey *et al.,* "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

SULPHUR

Uses. The principal use of sulphur is in the production of sulphuric acid, an acid used so extensively by modern industry that it is considered an index of a nation's economic activity. The largest sulphur consuming industry in the United States is the fertilizer industry. Sulphur is also used in large quantities by the chemical, paint and pigment, iron and steel, rayon and film, and petroleum industries. These industries use sulphur in the acid form. The paper industry uses large quantities of sulphur for sulphite pulp, and the insecticide and rubber industries use large amounts of elemental sulphur.

Present levels of utilization of sulphur in millions of long tons.

World (1966 production)	26.13
United States (1966 demand)	9.17

Ranges of demand projections to the year 2000.

Area	**Projection base**		**1970**	**1985**	**2000**
United States	FRB index				
		Low	9.7	17.0	29.9
		High	9.9	19.8	39.3
Rest of World	Steel production				
		Low	24.6	45.9	76.3
		High	25.4	55.8	102.4
Total World					
		Low	34.3	62.9	106.2
		High	35.3	75.6	141.7

Prospective supplies and prices. The overall resource base of sulphur-bearing materials both in the United States and worldwide is very large, but most sources (gypsum and anhydrite, pyrite in coal; oil shales and tar sand) are not presently economic. On the other hand, resources suitable for Frasch-process mining are quite limited and the supply responds slowly to price change. Also, production from sour gas, which currently supplies less than 10 per cent of the U.S. production is controlled by the demand for natural gas and by petroleum refinery capacity. Consequently, current sulphur production is insufficient to meet demand, the price is rising rapidly, and some sulphur-producing firms have put their customers on a quota of 65 per cent of their 1965 purchases. Looking some years to the future, an oversupply of sulphur is possible owing to increased recovery from fuel gases and the possible recovery of sulphur from effluent gases and solutions in pollution abatement operations. Domestic supplies may amount to 11.5 million tons per year by 1970 and foreign supplies to 24.0 million tons.

Domestic prices have increased, but are still lower than those of the rest of the world. The increases are not effective in stimulating enough new production to meet demand, and since some reliable sources of sulphur may produce less in the future, a price increase above the current $38 per ton for dark sulphur and $39 per ton for light sulphur is likely. Prices in the $42 to $45 per ton range are probable. In some years, after demand is met, prices will probably decrease to near present levels. World prices will remain higher than U.S. levels at least until supply and demand are balanced.

Possible substitute materials. Substitutes for sulphur or sulphuric acid have been developed for only a small part of total consumption; the ample supply and low cost of sulphur have restricted the use of substitutes. Hydrochloric acid could be used for steel pickling. Nitric acid, at a cost, could be used by the fertilizer industry where the introduction of sulphur is not required. Hydrofluoric acid may be used instead of sulphuric acid in manufacturing high-octane gasoline.

Potential from marine sources.[43] Table 2 summarizes the various known and future potential sources of sulphur in the continental shelves.

Elemental sulphur obtained from sulphur-bearing salt domes by the Frasch process in the Gulf of Mexico has been and will continue to be the most prolific offshore source in the United States. Although other sources of sulphur are available to supplement supply from salt dome deposits all are more expensive to mine or recover than Frasch sulphur, with the one exception of sulphur recovered from sour gas.[44] Elemental sulphur is recovered from domestic sour gas at the rate of 1.2 million tons a year, a level that will rise but not sufficiently fast to meet rising demand because this source is completely tied to natural gas demand rather than sulphur demand. To shift from salt dome sulphur to pyrite, to recovery of sulphur or sulphuric acid from base-metal ores, or recovery of sulphur-bearing compounds from liquid or solid fuels, can only result in a significant rise in the price of sulphur.

The amount of salt dome sulphur to be found in the continental shelves and slopes of the Gulf of Mexico is highly problematical. It is not yet known how many salt domes lie in the region nor how many contain sulphur-bearing caprock. Little is known about the geology critical to the discovery of sulphur deposits, because in the past all deposits were discovered by drilling in the search for oil. This was demonstrated during the last three years when sulphur companies failed to find deposits in offshore blocks they had nominated and for which they paid $33 million to the Government for exploration privileges.

Exploration for offshore salt dome sulphur deposits is controlled by U.S. regulations geared largely to the proprietary interest of the Government and designed to apply to the oil and gas industry. Yet the chance for discovery of sulphur is much lower, and therefore the cost of exploration much higher than in the petroleum industry. Out of a total of 329 salt domes known onshore and offshore in 1966 only 21 (1 in 16) were found to contain sulphur in economic amounts. This compares with a 1 in 10 discovery ratio for petroleum. Both the rate at which salt dome sulphur deposits will be found on the continental shelves and the cost of their discovery (reflected in cost of sulphur) are determined by Government policy and procedures.

THORIUM

Uses. The most important present use of thorium metal is in magnesium alloys. Thorium nitrate is of great importance in the fabrication of incandescent gas mantles. Nickel alloyed with thorium oxide possesses superior strength and corrosion resistance to temperatures of 2400°F. The oxide is also used as a catalyst in the petroleum and chemical industries. Thorium probably will become an important nuclear fuel as it can be converted in a nuclear reactor to U-233 which is fissionable and can sustain a chain reaction.

Present levels of utilization of thorium oxide (ThO_2) in short tons.

World (1966 production)	800
United States (1966 non-energy demand)	85

World demand cannot be estimated, because several countries class thorium as a nuclear-energy element and information on its disposition is classified. An undetermined portion of the production goes into governmental stockpiles. U.S. production is withheld to avoid disclosing company confidential data on monazite production.

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[43] V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

[44] A. J. Bodenlos, Geological Survey, written communication, 1968.

Table 2
KNOWN AND POTENTIAL SOURCES OF SULPHUR IN THE UNITED STATES

Types of deposits	Known occurrence in coastal States	Known and possible offshore occurrence	Extractive technology and economic status
Elemental sulphur in salt dome cap rock	Louisiana and Texas	Gulf continental margin	Economic Frasch process
Elemental sulphur in evaporite beds	West Texas	Possibly in the Gulf	Possibly by Frasch process
Elemental sulphur in volcanoes	California	None	Small production for local market
Hydrogen sulfide in sour gas (natural gas)	Mississippi	Unknown	Cheapest source of sulphur production
Hydrogen sulfide dissolved in stagnant sea water		Small quantities in restricted coastal embayments in the San Juan archipelago and deep basins off southern California	Not economical
Organic sulphur in crude oil	Gulf coast and Pacific coast highest in California crude	Southern California borderland	Economical recovery process (except residual fuel)
Organic sulphur in tar sands	None	Santa Barbara chemical	Feasible
Organic sulphur in oil shale	Alaska	Possibly off Alaska	Feasible
Sulfide, organic, and elemental sulphur in coal	Atlantic, Pacific, and Alaska regions	Off Alaska, Washington, Oregon	Costly process, but necessary to remove sulphur dioxide from smokes of coal burning plants to reduce air pollution
Sulfide sulphur pyrite and sulfide ores	Widely occur as pyrite deposits base-metal ores, sulfide bearing shales, etc.	Unknown	1) Economic to marginal production of sulphuric acid from pyrite 2) Marginal recovery of gas at base-metal smelters
Sulfide sulphur in organic rich marine mud		Stagnant basins off southern California and stagnant coastal embayments	Not economical
Sulfate sulphur in gypsum and anhydrite beds	Gulf coast	Gulf of Mexico	Most expensive process

Source: Geological Survey.

Ranges of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Resident population			
	Low	88	140	190
	High	90	170	265
Rest of World				
	GP	115	250	500
	Low	120	260	535
Total World	High			
		203	290	690
	Low	210	430	800
	High			

Prospective supplies and prices. Thorium is a by-product of the processing of monazite for the rare-earth elements, the large production of which creates an excess supply of thorium. Much of the monazite is imported from Australia and Malaysia. Thorite and thorianite are also sources of thorium. Both domestic and world reserves of thorium are very large and projected nonenergy needs to the year 2000 would scarcely make a dent in them. The price of thorium, in this case, should remain fairly steady.

Nuclear uses for thorium are in the experimental and developmental stages. The Peach Bottom, Pennsylvania and Elk River, Minnesota reactors are prototype nuclear power plants using thorium as part of the nuclear fuel. The development of an economic thorium converter or breeder reactor would create a large demand. Because such a development is unpredictable in timing and in competitive worth against uranium, no estimates of thorium demand for this purpose can be of value at this time. Even for such a large demand, reserves are ample to carry beyond the year 2000.

Possible substitute materials. No satisfactory alternate materials are suitable for the larger nonenergy uses of thorium, particularly in gas mantles and in alloys. Zirconium and titanium are superior to thorium as a getter in electronic tubes. Beryllia and yttria can substitute as a refractory above 2000°C. Uranium breeder reactors are competitive to a certain extent with thorium breeder reactors but neither has been sufficiently developed to predict which will find greatest use.

Potential from marine sources.[45] Monazite, a rare earth phosphatic mineral containing up to 12 per cent ThO_2, is the major source of the world's thorium. It is a fairly common accessory mineral in granitic rocks but is generally far too dilute in these rocks to be minable. Fortunately monazite's high density and resistance to chemical weathering favors its concentration in alluvial and beach sands.

Between 1895 and 1965 quantities of monazite have been recovered from modern and raised beaches in Florida and South Carolina, and minor quantities have been mined from beaches and alluvial placers in North Carolina, Georgia, and Gulf Coast States.[46]

An estimate of total monazite production between 1895 and 1962 from southeastern States' beach and alluvial deposits is 4,000 to 10,000 tons. Unfortunately, the ThO_2 content of these monazites averaged only 3½ to 4 per cent. Since the 1920's recovery of monazite has been limited to by-product operations principally concerned with the mining of rutile, ilmenite, and zircon. This was terminated in 1965 when black sand deposits were exhausted.[47]

The monazite placers in the southeastern States are richest near the headwaters of streams, closest to source rocks as might be expected. Closer to the sea the deposits are more widespread but the grade decreases. No data are presently available on the grades or volumes of offshore deposits but it seems reasonable to predict about 500 tons of monazite ore in offshore beach deposits.[48] However, because of the very low grade it would not be feasible to exploit these deposits unless concentrations of black sands were large enough to support the operation.

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[45] Summarized largely from Ocean Science and Engineering, Inc. report.

[46] J. C. Olson and K. C. Overstreet, "Geologic Distribution and Resources of Thorium," Geological Survey Bull. No. 1204, 1964.

[47] C. T. Baroch, "Thorium," in *Mineral Facts and Problems,* Bureau of Mines Bull. No. 630, 1965.

Monazite also occurs in beach sands along the California coast and thoriamite-uranothorianite is found in sands and gravels in California and Alaska. Again, low grade and insufficient volume of these sands does not permit profitable exploitation.

Thorium also is present in manganese nodules from the Pacific in concentrations ranging from 24 to 143 parts per million. However, a number of onland granites average 25 to 50 parts per million.

Overall, it appears unlikely that monazite or other thorium-bearing minerals will be recovered from U.S. offshore sources before the year 2000 except as a possible by-product of black sand operations.

TIN

Uses. An unusual combination of properties–low fusibility, malleability, resistance to corrosion and fatigue, and ability to alloy with other metals–accounts for the many uses of tin. The largest use of tin is as a protective coating for copper, steel, and other stronger materials, mainly in the form of tinplate for cans. The second largest use of tin is in soft solders–tin lead alloys; because tin alloys readily with most metals, it is the essential constituent of the solders. Another large use of tin is in making brass and bronze. Substantial quantities are also used in possible alloys in producing babbitt, pewter, type metal, and diecasting. Small quantities of tin are consumed in chemical reagents and compounds used in making glass, ceramics, and other products.

Present levels of utilization of tin in long tons.

World	230,000
United States	85,486

Ranges of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Steel production			
	Low	88,000	93,000	100,000
	High	89,000	97,000	108,000
Rest of World				
	Low	148,000	173,000	192,000
	High	153,000	189,000	222,000
Total World				
	Low	236,000	266,000	292,000
	High	242,000	286,000	330,000

Prospective supplies and prices. U.S. resource base is neglible. However, most of the world requirements of tin at least until 1985 can be supplied from presently known reserves of about 4.5 million tons of contained tin, principally in the Far East. Substantial undeveloped resources are also available to meet potential demand. Since a large part of the world supply of tin comes from politically unstable countries, political upheavals could occur that might affect the future supply and price of tin.

Although the average price of tin has declined in recent years the price has become more stable largely through the influence of the sales from government surplus stocks and to stabilizing actions taken by the International Tin Council. However, a slow, long-term rise in prices to the range of $1.50 to $2.00 per pound can be expected. The average annual U.S. growth rate in tin consumption from 1966 to 1980 is expected to be about 1 per cent. Virtually all of the U.S. supply of primary tin will be obtained from imports.

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[48] *Ibid.*

Possible substitute materials. In the largest use of tin—as tinplate for cans—there are numerous alternate materials, including glass, paper, plastics, and aluminum. Nonmetallic materials, copper, aluminum, and zinc-coated products, have largely replaced tinplate and terneplate for roofing and construction. Silver or antimony may be used in solder in place of tin. In other alloys, low-tin bronze and roller or ball-bearings may be substituted for babbitt metal containing tin. Wrapping material such as aluminum, plastics, or paper may replace tinfoil. Other chemical compounds may replace tin compounds for use as fungicides and insecticides, slime-control reagents, and an enamel opacifier in ceramics.

Potential from marine sources.[49] The United States has no known primary tin deposits of economic grade or size. Primary tin deposits are associated with granitic rocks which generally are known to be present in only a few places in the U.S. continental shelves.

Cassiterite, the only commercial tin mineral, is readily concentrated in placers; large and rich tin placers are being exploited in several areas of the world. The only tin placers of significant size in the United States are on the western tip of the Seward Peninsula;[50] these are being worked by four to eight men during the summer months. Total production is unknown but probably is less than $200,000 annually. Reserves are estimated to be 3,000 tons, worth perhaps $6-8 million. However the deposits are in small pockets, difficult to work, thus deterring the development of large production facilities. No offshore sampling has yet been done but a small low grade cassiterite deposit totaling perhaps 1000 tons may be inferred off the Seward Peninsula. No other tin deposits are likely on the U.S. continental shelves or on the shelves of Hawaii, Puerto Rico, or the Virgin Islands.

TITANIUM

Uses. More than 95 per cent of titanium is used as titanium dioxide in pigments. Titanium is also used as a metal, as welding rod coatings, for non-titanium-base alloys and carbide, and for ceramics, fiber glass, and chemicals. Its use as a structural metal is increasing, particularly in the aerospace industry, where its high strength-to-weight ratio holds an advantage over aluminum and stainless steel. Titanium is not a rare element, being the ninth most abundant in the continental crust.

Prospective supplies and prices. The titanium resource is in the form of two minerals: ilmenite and rutile. Ilmenite is eminently suitable and widely used as a source for titanium dioxide used in pigments. Rutile however is preferred over ilmenite as the raw material for titanium metal because of metallurgical factors. Both the United States and the world have large land-based resources of ilmenite. Australia and Sierra Leone are the chief sources of rutile.

The trend in the price of primary titanium (sponge metal) has been continually downward since the metal was first produced commercially in 1948. Commercial titanium sponge sold for about $5.00 per pound in 1948 and by the end of 1963 was selling for $1.27 to $1.60 per pound. Owing to abundant supplies of titanium raw materials and a high relative use of electric power (which shows a downward price trend) it is likely that the price of titanium will continue to decline although more slowly than in recent years.

Possible substitute materials. Selection of titanium metal over other materials of construction is normally made on a performance versus economic basis. High-strength steels, aluminum, or other metals may be substituted for titanium in many structural applications but such substitution usually necessitates redesign and results in lower performance. In applications where titanium's corrosion

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[49] Summarized largely from Ocean Science and Engineering, Inc. report.

[50] J. E. Shelton, "Tin," in *Mineral Facts and Problems,* Bureau of Mines Bull. No. 630, 1965.

Present levels of utilization of titanium in short tons.

World (1966 estimated consumption)	28,000
United States (1966 consumption)	19,677

Ranges of demand projections to the year 2000.

Area	Projection base	1970	1985	2000
United States	Historic growth compared to aluminum, plus other considerations			
	Low	25,000	100,000	300,000
	High	40,000	200,000	600,000
Rest of World	Same as above			
	Low	10,000	50,000	200,000
	High	20,000	120,000	500,000
Total World				
	Low	35,000	150,000	500,000
	High	60,000	320,000	1,100,000

resistance is a deciding factor, other metals such as stainless steel, Hasteloy, and certain nonmetals may be used, but these are often more expensive than titanium when downtime and replacement costs are considered.

Possible source materials other than rutile for producing titanium metal include manufactured titanium dioxide, ilmenite, and titanium slag. Use of any of these alternates would increase the cost of titanium metal.

Potential from marine sources.[51] Of the two commercially important titanium minerals, ilmenite is far more abundant and cheaper than rutile and is mined on land from beach sands and from lode deposits. Rutile has its principal source in beach sands. Ilmenite and rutile commonly occur in beach and alluvial placers with zircon, monazite, magnetite, and other resistant heavy minerals.

Large and rich concentrations of ilmenite and rutile are most likely to occur in physiographically mature areas such as along the east and west coasts of Australia and off the Atlantic coast of the southeastern United States. High concentrations of titanium sands are found in all of these areas. Ilmenite and rutile are also fairly abundant along the Oregon coast but total volumes of black sand are relatively small and concentrations are low.

Black sand production and reserves in beach and dune deposits in Florida and other southeastern States have been estimated to contain 30-50 million tons of ilmenite, 1-2 million tons of rutile, and 7-10 million tons of zircon.[52] Deposits now being worked average about 4 per cent heavy minerals, of which 40 per cent is ilmenite, 7 per cent is rutile, and 11 per cent is zircon.[53] Deposits range up to 20 miles long, 1 mile wide, and 35 feet thick.

The richest deposits along the South Carolina and Florida coasts are farthest inland, presumably closest to source rocks, and the deposits become lower in grade nearer the coast. Thus, offshore deposits may be expected to be low grade. An inferred 5-10 million tons of ilmenite in beach and dune placers on the Continental Shelf containing 0.5 to 1.5 per cent ilmenite and from 0.2 to 0.4 per cent zircon seems reasonable. The concentrations of rutile and monazite will be much less. Most of the inferred deposits will probably be in water 30 to 120 feet deep. These inferred grades and volumes are too low to be presently competitive with domestic and foreign titanium ores.

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[51] Summarized largely from Ocean Science and Engineering, Inc. report.

[52] J. W. Stamper, "Titanium," in *Mineral Facts and Problems,* Bureau of Mines Bull. No. 630, 1965.

[53] J. C. Detweiler, "Jacksonville Plant Produces Titanium from Beach Deposit." *Mining Engineering,* Vol. 4, No. 6, June 1952.

YTTRIUM

Uses. The major and only commercial use of yttrium is in yttrium-iron garnets called "yigs" in the electronics industry. These serve as filters for selecting or tuning microwaves. Other potential commercial uses are in nuclear reactors and as an additive promoting the formation of nodular graphite in ductile cast iron.

Present levels of utilization of yttrium in short tons.

World (1966 production, mostly yttrium contained in concentrates, estimated)	315
United States (1966 demand, based on sales of purified oxide)	50

Ranges of demand projections to the year 2000.

Area	Projection Base		1970	1985	2000
United States	Resident population				
		Low	77	260	456
		High	92	373	728
Rest of World	Resident population				
		Low	15	42	79
		High	16	47	89
Total World					
		Low	92	302	535
		High	108	420	817

Prospective supplies and prices. Domestic reserves of the yttrium-bearing minerals (monazite and xenotime in the southeast and monazite and euxenite in the northwest) are conservatively estimated in excess of 2,000 tons of contained yttrium. These sources would suffice for U.S. demand until nearly 1985 at a price of about $64 per pound of contained yttrium (based on a current price of about $50 per pound of refined oxide). Current U.S. demand relies heavily on imports of crude yttrium salts which are by-products of uranium ore processing. Supplies from the Canadian source, or possibly from a similar domestic source, added to domestic southeast and northwest mineral deposits, are adequate to meet domestic demand to the year 2000. If needed, extremely large quantities could be recovered at markedly higher prices as by-products from phosphate deposits throughout the world.

Possible substitute materials. In the electronics industry cheaper and more plentiful materials such as the spinel-type ferrite compounds can substitute for yttrium-iron garnets, but they give less satisfactory performance.

Potential from marine sources. Yttrium is always found in association with rare earths. It is concentrated mainly in xenotime (essentially an yttrium phosphate) and to a lesser extent in monazite and other minerals. It is sometimes concentrated in apatite the principal mineral of phosphorite. The potential for yttrium production thus depends on the abundance of xenotime and monazite in black sands (see section on monazite).

ZIRCON

Uses.[54] More than half of the zircon is used in its mineral form; the remainder is used to produce zirconium metal, alloys, and compounds. Refractories constitute the principal use of zircon. Other uses are in chemically resistant ware, enamels, pigments, electrical insulators and resistors, glazes, glass polish, heat transfer pebbles, porcelains, and abrasives.

The physical properties of zirconium have led to its extensive use in nuclear reactors. The powerplants of a number of naval vessels contain zirconium. The corrosive resistance of zirconium makes it suitable for many applications in the chemical industry. Numerous zirconium alloy systems have been developed.

Possible substitute materials.[55] Alumina may be substituted for zircon as a mold aggregate but is more expensive. Silica and olivine can be used in some cases as substitutes in refractory applications. Titanium oxide and tin oxide may be substituted as opacifiers in ceramic glasses and enamels.

Stainless steel is an alternate for zirconium metal in nuclear structural applications, white aluminum, columbium, and vanadium may be used in place of zirconium for fuel containers. Stainless steel and titanium are substituted for zirconium in many corrosion-resistant industrial applications. In ferrous metal applications, manganese, vanadium, and several other elements may be substituted as deoxidants.

Present levels of utilization of zircon in thousands of short tons.

World (1966 production)	400,000
United States (1966 demand)	100,000

Ranges of demand projections to the year 2000.

Area	Projection base		1970	1985	2000
United States	Resident population				
		Low	115	175	235
		High	120	210	320
Rest of World	Steel				
		Low	270	460	620
		High	300	590	850
Total World					
		Low	385	635	855
		High	420	800	1,170

Prospective supplies and prices. Zircon is now recovered only as a co-product, or by-product, of heavy minerals. Domestic and world resources can satisfy the foreseeable demand, but at current prices supply will depend on other heavy mineral production. Large quantities now being discarded could be recovered from other mining operations.

Prices quoted for zircon, $45-55 per short ton for bulk shipment f.o.b. mine or bagged c.i.f. Atlantic ports, are largely nominal and are allied closely with prices and production of other heavy minerals of placer deposits, particularly rutile. Small lots of zircon for specialty uses sell for $80-$100 per short ton.

If the price of rutile were lowered substantially, producers of heavy minerals might increase the price of zircon proportionately in order to stay in business.

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[54] Summarized from D. E. Eilertson, "Zirconium," in *Mineral Facts and Problems,* Bureau of Mines Bull. No. 630, 1965.

[55] *Ibid.*

Potential from marine sources.[56] Zircon, the sole source of zirconium is a highly resistant mineral that is commonly concentrated in beach, dune, and alluvial sands with rutile, ilmenite, magnetite, and monazite. In 1965 three U.S. firms were producing zircon from ancient beach and dune deposits in northern Florida.[57] However, a large part of the 35,000 tons of zircon consumed in the United States was imported from Australia.

Zircon reserves in beach sands in the United States are estimated to exceed 12 million tons. Almost 90 per cent of the reserves are in Florida, South Carolina, and New Jersey. Zircon comprises 5 to 10 per cent of the heavy minerals found in the deposits of these areas where the total heavy mineral concentrate comprises 4 to 17 per cent of the sands. An additional one to two million tons of zircon can be inferred in offshore deposits but the expected grades will be considerably less than in onshore deposits because of the greater distance from source rock areas. Consequently the possibilities of offshore production of zircon on the east coast are very poor.

The same general situation exists on the west coast. Onshore reserves, estimated at 90,000 tons, have never been exploited on a significant scale. Offshore reserves in significant concentrations cannot be expected to exceed those onshore. Any recovery of zircon would necessarily be a by-product of a venture recovering gold or other heavy minerals.

The United States contains about half the world's known zirconium reserves in low grade on-land deposits,[58] so it appears doubtful that offshore recovery operations would be necessary for strategic reasons.

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[56] Summarized largely from Ocean Science and Engineering, Inc. report.

[57] Eilertson.

[58] *Ibid.*

Appendix B **Summary of State and Local Activities in Non-Living Resources**[1]

State	*Operating Level*	*Responsible Agencies and Professional Staff where given ( )*	*Function*	*Statistics*	*Problems*
Maine	State	Maine Geological Survey (3)	Advisory, planning, and operation		
		Governor's Task Force on Oceanography	Coordination		
	Local	None			
	Interstate or regional	None			
New Hampshire	State	Office of the State Geologist (1)	Advisory and planning	No marine resources exploited at present. Whole New Hampshire coastline heavily developed with cottages and recreational facilities.	
		Dept. of Resources and Economic Development	Deals with all marine resources		
		Council of Resources and Development	Deals with all resources		
	Local	None			

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[1] Summarized from report by J. I. Thompson & Company, "A Perspective of Regional and State Marine Environmental Activities" prepared for the Institute of Public Administration, under contract to the Commission on Marine Science, Engineering and Resources, February 1968.

SUMMARY OF STATE AND LOCAL ACTIVITIES IN NON-LIVING RESOURCES (Continued)

State	*Operating Level*	*Responsible Agencies and Professional Staff where given*	*Function*	*Statistics*	*Problems*
New Hampshire (Cont'd)	Interstate	Maine-New Hampshire Bi-State Commission on Oceanography	If approved by Maine legislature will coordinate interstate activities		Legislative approval by State of Maine; funding
Massachusetts	State	Division of Waterways Dept. of Public Works	Regulates on basis of an existing law concerning removal of gravel etc. from tidal shores	No produced revenue or costs available relative to marine resources	
		Local governments may call hearings upon any application to remove, dredge, or fill.			
	Interstate	None			
Rhode Island	State	Rhode Island Dept. of Natural Resources (13)	Regulatory. Approves or denies requests for proposed work that may affect tidal zones or navigable waters		
	Local	Rhode Island Development Council	Plans and coordinates marine activities between State and local governments	No revenue derived by state; no monies expended	
	Interstate	None			

Connecticut	State	Water Resources Commission	Controls dredging operations for fill or commercial sand and gravel	Annual cost to State is $20,000 to regulate dredging operations	
	Local	None			
	Interstate	None			
New York	State	New York State Conservation Dept. Two divisions: Oil and Gas	Advisory, planning, regulatory, coordinating. Promotes utilization of minerals, sand and gravel, and oil and gas in a way to secure maximum recovery and benefit to State.	Regulatory costs of about $20,000 per year for oil and gas and $15,000 per year for sand and gravel are borne by the state. Gross economic value of sand and gravel is $20 million per year.	Overcoming local resistance to development; convincing sportsmen, recreational interests, and commercial fishing interests that exploitation of minerals can be conducted compatibly with other uses of the marine areas; and prevention of pollution.
		Division of Water Resources	Desalination and energy conversion		
		Water Resources Commission	Advisory, planning, research, operation, regulation, and coordination. Issues permits, etc.		
		State Geologists Office, New York State Museum and Science Service, Dept. of Education	Advisory, planning, and research		

SUMMARY OF STATE AND LOCAL ACTIVITIES IN NON-LIVING RESOURCES (Continued)

State	*Operating Level*	*Responsible Agencies and Professional Staff where given*	*Function*	*Statistics*	*Problems*
New York (Cont'd)		Office of Planning Coordination	Planning and planning research. Assesses the utilization of marine mineral resources in relation to plans for all activities		
	Local	Local governments	Zoning of shore facilities; exploration and exploitation problems		
	Interstate	Great Lakes Commission	Advisory and coordination		
		Lake Erie Oil and Gas Commission	Informal body–regulatory and coordinating		
		Interstate Oil Compact Commission	Advisory and coordinating		
		North Atlantic Regional Water Resources Study Coordinating Committee	Conducts interstate water resource studies		
New Jersey	State	State Dept. of Conservation and Economic Development	Five divisions within this organization carry out advisory, planning research, regulation, and coordination. Total overall management of marine mineral resources.	State receives $167,000 gross revenue from sand and gravel mining; seawater magnesite plant also provides State income.	Conflicts with recreational uses of beach and bay areas, deleterious effects on shell fishery beds, deleterious effects on ecology of marine life.

New Jersey (Cont'd)	Local	Local authorities	Historically have been left to solve problems concerning land-use planning and zoning and destruction of and building on sand dunes.		
	Interstate	Delaware River Basin Commission	Optimum utilization of the basin's water and related resources within a comprehensive plan		
Delaware	State	Delaware Geological Survey (5)	Stimulate industry interest in exploiting the shelf and shoreline		
	Local	None			
	Interstate	Delaware River Basin Commission	(See New Jersey)		
Maryland	State	Maryland Geological Survey (5)	Advisory, planning, research, and coordination		At present such exploitation that problems are not yet clearly defined. No revenue is provided the State.
		Dept. of Chesapeake Bay Affairs	Advisory, operating, and regulatory. Approves and manages the exploitation of resources, coordinates between State and local governments		
		Maryland Board of Natural Resources	Handles coordination among state agencies. Plans long-term patterns of resource management, but no significant planning yet done.		

SUMMARY OF STATE AND LOCAL ACTIVITIES IN NON-LIVING RESOURCES (Continued)

State	*Operating Level*	*Responsible Agencies and Professional Staff where given*	*Function*	*Statistics*	*Problems*
Maryland (Cont'd)	Local	None			
	Interstate	Interstate Oil Compact Commission	Coordinating, advising, planning, and research		
Virginia	State	Division of Mineral Resources of the Dept. of Conservation and Economic Development (30)	Mainly concerned with non-marine resources.	None	Dredging of oyster shell and sand and gravel changes salinity patterns and floras that may have significant effects on oyster population; inadequate knowledge concerning mineral resources
		Division of Mines and Quarries of the Dept. of Labor and Industry	Regulates mining and oil/gas drilling onshore		
		Virginia Institute of Marine Science	Research, development, and advisory services		
		Commission of Fisheries	Regulates bottom rights and mineral mining. Issues permits, contracts, and leases.		
	Local	None			
	Interstate	None			

North Carolina	State	Division of Mineral Resources of the Dept. of Conservation and Development (9)	Advisory and regulatory. Recommends and administers leases to explore and exploit.	State derives $78,000 yearly gross revenue from leases. Cost to State is $1,000 to regulate minerals exploitation and $1,500 to regulate oil and gas exploitation. State has executed leases with six companies to explore and exploit but none actually doing it. Three are paying annual rents based on averages.	
	Local	None			
	Interstate	Coastal Plains Regional Commission	Planning and research, but not enough experience in this field yet to define problems		
South Carolina	State	Division of Geology, State Development Board	Research and appraisal of marine mineral resources	One mineral lease in effect for phosphate exploration	Conflict between private and public sectors on ownership of marsh and beach. Potential conflict between mineral exploitation and fisheries and resort development.
		State Pollution Control Authority	Regulates marine resources activities		
	Local	None			
	Interstate	None			
Georgia	No information provided				
Florida	State	Florida Board of Conservation Division of Geology (13)	Advisory, planning, research, regulatory, coordinating	State derives revenues as follows: shell leases $355,596; oil and gas leases $69,600; sand and limestone leases $32,000; seismic permits $4,000.	Conflicts in uses of the waterfront; fear (largely unjustified) of water pollution.
	Local	Counties	Contribute to research and planning		

SUMMARY OF STATE AND LOCAL ACTIVITIES IN NON-LIVING RESOURCES (Continued)

State	*Operating Level*	*Responsible Agencies and Professional Staff where given*	*Function*	*Statistics*	*Problems*
Florida (Cont'd)	Interstate	Interstate Oil Compact	Conservation of oil and gas by prevention of physical waste.	No present production of oil and gas from submerged lands. Regulatory costs to State are $1,000 per annum for mineral extraction and $5,000 for oil and gas production.	
Alabama	State	Dept. of Conservation	Sells leasing rights and supervises seismic work in tidal waters	State derives $250,000 annually from shell dredging industry. Gross value of shells mined is $5 million annually. Sand provides a gross economic value of $10,000. Administrative and regulatory costs to State are $8,000.	Pollution and conflicting demands for use
	Local	None; industry is responsible for planning, research, and development			
	Interstate	None			
Mississippi	State	Mississippi Geological Survey (6) Mineral Lease Commission	Research and basic data collecting Regulates exploitation	Unknown quantities of sand and gravel have been dredged; about $429,000 worth of shells dredged	Stimulating interest in marine mineral resources
	Local	None			
	Interstate	None			

Louisiana	State	Dept. of Conservation (28)	Regulatory; conservation	The following revenues are derived annually for oil and gas: bonuses, $5 million; rentals, $0.5 million; royalties, $25 million; severance tax, $214 million. Costs of regulatory effort to State are: minerals, including oil and gas, $1,825 million; sand and gravel, $0.4 million. Total value of oil extracted in 1967 was $671 million.	Conflicting interests between oyster leases and oil and gas leases; navigational restrictions on oil and gas exploration facilities; exposure to the elements and subsequent damage to oil and gas facilities from corrosion and hurricanes.
		Louisiana State Mineral Board (19)	Grants and administers leases.		
	Local	None–industry conducts all the work			
	Interstate	Interstate Oil Compact Commission	Advisory		
Texas	State	Texas Water Development Board	Planning, research, and development involving desalination and living resources	Economic value to State is extensive. Over 11 million cubic yards of oyster shell is estimated yearly yield. Regulatory costs amount to about $75,000 per year for this operation.	
		Texas Railroad Commission	Regulates and manages oil and gas production		
		General Land Office	Authority not known		
	Local	None			
	Interstate	None			

SUMMARY OF STATE AND LOCAL ACTIVITIES IN NON-LIVING RESOURCES (Continued)

State	Operating Level	Responsible Agencies and Professional Staff where given	Function	Statistics	Problems
California	State	Dept. of Conservation Division of Mines & Geology (36)	Unfunded advisory, planning, coordinating. Will conduct research when funded.	A yearly gross revenue of $41.5 million is derived from oil and gas, $0.4 million from land rentals, and $0.4 million from mineral royalties. State spends about $1.84 million for regulatory effort annually. Yearly mineral production is: 632,000 yards, oyster shells, FY 1967 with gross economic value of $126,309; 1.1 million cubic feet of sand and gravel, gross economic value of $472,000; 2 million tons of salt per year; 136,000 tons of magnesia per year; 1,000 pounds semi-precious stones (jade and jasper); 24.5 million barrels of oil and 72.3 million cubic feet of gas with gross yearly economic value of $88.8 million	Lagging oil exploitation technology does not permit extraction from water 600 feet or more deep. Conflicts between various industry, conservation, and county and city groups on use and restrictions of use for marine areas.
		State Lands Commission (170)	Planning, development of operations, regulatory, coordinating. Has legal authority to sell, lease, or dispose of public lands including tidelands and submerged lands. Also operates analytical laboratories.		
		State Lands Division (80)	Supervisory and regulatory		
		Interagency Council on Ocean Resources	Lead coordinating agency concerned with overall exploitation of marine resources.		
	Local	City of Long Beach	Regulates tidelands oil		
		Santa Barbara County	Resolves problems concerning offshore oil development		
	Interstate	None			

Oregon	State	Oregon Dept. of Geology and Mineral Industries (21)	Development, regulation, and coordination	Yearly gross revenue of $28,000 is derived from marine mineral leasing operations. A total of $2,000 was spent annually on oil and gas regulation; nothing for hard minerals	Lack of state laws to encourage or guide exploration and exploitation of hard minerals; conflict of interest with fishing industry.
		Governor's Committee on Oceanography	Advisory, planning, and coordination		
	Local	None	All developmental work is conducted by industry.		
	Interstate	Interstate Oil Compact Commission	Coordination		
		Western Governors' Mining Advisory Council	Advisory		
Washington	State	Dept. of Natural Resources	All aspects		
Alaska	State	Dept. of Natural Resources	Planning, research development, mine safety, issuing permits, leasing	About $11.2 million is received by the State from oil and gas royalties. Regulatory efforts cost the State $170,000 for oil and gas.	Making mineral rights available for permit or lease and the proper timing of lease sales. Maximum economic recovery of oil and gas. Multiple use of lands for various purposes. Limited promotion of mineral resources. Determination of boundaries between State lands and Federal OCS lands.
		Dept. of Health & Welfare	Health		
		Dept. of Economic Development and Planning	Promotion		
		Dept. of Labor	Petroleum safety		
		Oil and Gas Conservation Committee	Regulates exploration, development, and production of oil and gas		
	Local	None except taxation			
	Interstate	Interstate Oil Compact Commission	Advisory, planning, research, regulation, and coordination		

SUMMARY OF STATE AND LOCAL ACTIVITIES IN NON-LIVING RESOURCES (Continued)

State	*Operating Level*	*Responsible Agencies and Professional Staff where given*	*Function*	*Statistics*	*Problems*
Hawaii	State	None (apparently little activity in mineral resources)			
Minnesota	State	Minnesota Geological Survey	Advisory and research		Disposal of non-pollutional waste materials in public waters.
		Division of Waters, Soils and Minerals, Minnesota Conservation Department	Advisory, regulatory, coordinating		
		State Planning Agency	Planning and coordinating between state and local governments		
Wisconsin	State	None			
Illinois	State	None			
Indiana	State	Dept. of Natural Resources	No activity		
	Interstate	Great Lakes Basin Commission			
Michigan	State	Geological Survey–Division of the Dept. of Conservation	Advisory	Many thousands of dollars paid to State for sand and gravel leases over last 30 years.	Pollution control, mechanical problems recovering metallic ores from beneath Lake Superior.
		Conservation Commission	Issues leases on advice from Lands Division and Geological Survey Division for sand and gravel exploitation. Policy does not allow drilling or exploration		

Michigan (Cont'd)	Local	None			
	Interstate	Interstate Oil Compact Commission (10)	Advisory		
Ohio	State	None reported			
Pennsylvania	State	Dept. of Mines and Mineral Industries (100)	Control and regulation of oil and gas operations.	No marine mineral resources are being exploited	Pollution abatement safety and conservation of resources.
		Dept. of Forest and Waters (350)	Leasing mineral rights		
		Dept. of Health (70)	Water pollution abatement and water supply inspection		
	Local	None related to mineral resources			
	Interstate	Delaware River Basin Commission (30-40)	Pollution control and water allocation		

Appendix C Hypothetical Dredging Operations

I. Hypothetical Offshore Dredging Operations in Shallow Water

It may be useful to evaluate a hypothetical offshore dredging operation in order to bring some of the problems into clearer focus. Two examples are used. One assumes an operation in Norton Sound off Alaska where severe weather conditions prevail during a large part of the year. The other assumes an operation in waters where less severe environmental conditions prevail, as say off the coast of Oregon.[1]

In order to limit the variables, certain basic assumptions about the deposit are made:

–The deposit is located one mile offshore and the combined depth of water and deposit thickness does not exceed 150 feet.

–The deposit is amenable to exploitation using standard bucket line dredging methods, giving a recovery factor of 90 per cent.

–The deposit grade averages 75 cents per cubic yard and the reserves are equal to the life of the dredge.

–The estimates used in detailing capital expenditures are valid. The estimates are basically engineering cost evaluations and factors such as potential pollution problems, royalty payments, and other possible resource costs are not included. Moreover, it should be emphasized that for initial ventures with high capital investments returns would have to be well above normal to compensate for the risk.

The above assumptions are made to compensate for the lack of real data, which would normally be available, and although they are for the most part artificial, they are based on sound engineering practice and judgment.

A. Operational Variables

Analyses have been made previously for three standard sizes of bucket line dredge, of 9, 12, and 18 cubic feet bucket capacity which cover the general range of bucket line dredges currently employed in land mining operations below 100 foot depth. These analyses showed that, working in the Bering Sea, none of these dredges would produce a sufficient return on investment to justify exploitation of deposits valued at $1 per cubic yard. This study is therefore based on a 54 cubic foot dredge, which though never previously used for mining, is quite practical from an engineering standpoint. Certain of the data relating to this dredge are extrapolated graphically, other from previous work.

B. Limitations on Operations

In Norton Sound, ice conditions prevail which limit operations to a maximum of 185 days out of the year with allowance made for 11 days of extreme storm condition. During the winter months the dredge would be maintained at Anchorage in Alaska and only the salaried staff retained. Travel time between Anchorage and the dredging ground would amount to some 14 days, during which time the operational crew would remain aboard.

In other more protected areas, these conditions do not prevail and cost analyses for 362 work days per year are shown for comparison. These are based on a 22-hour day.

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[1] **Evaluation by the Bureau of Mines Marine Mineral Technology Center, Tiburon, California. C. M. Romanowitz, an expert on dredging, served as a consultant in this study.**

C. Estimated Capital Requirements

–Equipment. The dredge chosen for this work is a continuous high speed bucket line dredge of 54 cubic feet bucket capacity digging to a depth of 150 feet. The dredge is self-propelled and mounted on a sea-going hull. A diesel electric generating plant provides motive and dredging power. Crew consists of 6 officers and 31 men to maintain 24-hour operations. No firm bids have been sought for such a vessel but an authoritative estimate of cost is $32 million, the sea-going requirement elevating cost somewhat beyond that of comparable dredges for inland waters. In open waters, it is also necessary to provide a substantial support vessel for shore liaison, laying anchors, and mining control. The craft envisaged is a 70-foot diesel powered vessel adaptable for haulage, survey, and drilling, costing $250,000.

–Property acquisition costs. Assuming that target location had been previously carried out, a minimum of 5,000 acres would be acquired. An arbitrary purchase cost of $10 per acre is applied, though this may be low.

–Expenditures for initial exploration and development. Geophysical survey of the eight square mile area is assumed carried out at a cost of $1,000 per square mile. This includes shipborne topographic, subbottom, and magnetometric profiling and interpretation, on a maximum half mile grid spacing. This projection allows 50,000 feet of drilling at $20 per foot; again, this figure may be low.

The Office of Mineral Exploration could assume 50 per cent of exploration costs for gold at a charge of 5 per cent royalties on production. However, this option benefits principally smaller operations than assumed here and it is not part of the hypothesis.

–Inventories and receivables. An amount equalling approximately 3 per cent of major equipment cost is a conservative estimate for spare parts inventories, supplies held on the dredges and similar items.

–Working cash balance. A cash balance must be maintained, particularly in an outlying station for emergency requirements and advances in pay.

–Pre-operating expenses. A number of expenses will be incurred prior to production, in such areas as organization of survey stations, shore stations, and transport of dredge to the site.

–Start up costs and initial operating losses. It is unlikely that any appreciable production will be realized in the early days of the operation; a non-productive period of at least one month should be expected. An arbitrary figure of 25 per cent of the estimated annual operating costs is allowed to cover all items in 5, 6, and 7.

Economic Analysis Tables 1, 2, and 3 which follow tabulate the Capital Requirements, Operating Costs, and Profitability computed for both Norton Sound and a sheltered coastline where weather is not a major deterrent to operations. Increasing the working time reduces the operating cost considerably, and costs per cubic yard of 22.9 cents are shown for a 185-day operation, compared with 16.5 cents for a 362-day operation.

Estimation of the annual return on initial investment (ROII) is shown for the two operations. ROII for Norton Sound is 5.4 per cent; the return for the sheltered coast operation is 11.7 per cent. Although both operations would pay off within the 20-year life of the dredge, neither of them would be considered an attractive investment commensurate with the high risk involved. Higher values of ore would greatly improve the attractiveness of the operation.

II. Hypothetical Deep Sea Manganese Operation

It appears likely that capability to exploit manganese nodules from the ocean floor at depths of about 15,000 feet is also 10 to 15 years away. Not only are there distinct technical problems in materials handling and mining control at such depths, but it is not yet possible to profitably extract the contained

Table 1
CAPITAL REQUIREMENTS

	Norton Sound	Sheltered Coast
(1) Equipment		
Dredge, 54 cubic feet	32,000,000	32,000,000
Support vessel	250,000	250,000
	32,250,000	32,250,000
(2) Development		
Property acquisition costs–5,000 acres	50,000	50,000
Expenditure for initial exploration and development–5,000 acres 8 miles^2		
geophysical 1,000/mile^2	8,000	8,000
drilling 50,000 feet at $20	1,000,000	1,000,000
	1,058,000	1,058,000
(3) Working Capital		
Inventories and Receivables (3 per cent of Major Equipment)	968,000	968,000
Working Cash Balance Pre-operating Expense 25 per cent Start-up Costs Annual Operating Cost Initial Operating Loss	463,150	646,425
	1,431,150	1,611,425
Total	34,739,150	34,922,425

metals (Mn, Fe, Co, Cu, Ni) from the nodules. The development of excavating equipment will require considerable knowledge of the characteristics of the deposit. Little information of this type is available for any area at the present time.

The following is an economic evaluation of a hypothetical manganese nodule deposit:[2]

The deposit is located in the area between the Clipperton and Clarion fracture zones in the East Pacific at a depth of 15,000 feet. Los Angeles is 1,200 miles to the north, and Hawaii, 2,500 miles to the west.

An analysis of the more critical metals and minerals content is given as Mn 24.0 per cent, Ni 1.4 per cent, Cu 1.2 per cent, Co 0.25 per cent, SiO_2 16 per cent, and $Ca CO_3$ 3.5 per cent. This is consistent with known deposits located in the East Pacific. The lime content is low compared to the silica content. This has a considerable effect in reducing the cost of the metallurgical processes. A nodule density of two pounds per square foot is assumed as being typical of this area and a shallow surface layer is assumed.

It is assumed that reserves are equal to the life of the mine system. For the purposes of amortization of capital equipment, a life of 10-50 years is estimated, but an actual working life of 20 years may be

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[2] Evaluation by Bureau of Mines Marine Mineral Technology Center, Tiburon, California. No research on which to base this study is available, but the overall approach is believed to be sound.

Table 2
OPERATING COSTS

	Norton Sound	Sheltered Coast
Number of Operating days	185	362
Annual Yardage	8,100,000	15,675,000
Direct Costs:		
Supervision 6 @ $20,000	120,000	120,000
Labor 31 @ $50/day	308,000	566,000
Supplies @ 100 per cent labor	308,000	566,000
Power @ 2 cents/yd	162,000	314,000
	898,000	1,566,000
Indirect costs:		
Support vessel $300/day	59,700	108,500
Shore station $100/day	19,900	36,200
Depreciation on dredge (20 yrs)	640,000	640,000
Depreciation on vessel (10 yrs)	25,000	25,000
Ins. & Taxes, Equipment 6.5 per cent	210,000	210,000
	954,600	1,019,700
Total Operating Cost	1,852,600	2,585,700
Operating costs/yd^3	22.9 cents	16.5 cents
Direct costs/yds^3	11.1 cents	10.0 cents

expected. On this basis, reserves will equal 30 million tons and extend over an area of nearly 1,100 square miles.

The seafloor in the deposit area is assumed to be flat and of sufficient strength to support a properly designed mining vehicle.

All of the foregoing assumptions on the deposit characteristics have a bearing on the choice of the mining system. Other significant factors are:

–Rate of production. The production rate stipulated is 5,000 tons per day. The following rates are used for all computations:

208 tons/hour
5,000 tons/day (24 hours)
150,000 tons/month (30 days)
1,500,000 tons/year (300 days)

The figure for working days is low to allow for regular maintenance and severe storm conditions.

–Mining method. The total area required to be covered each day is 5 million square feet or nearly 115 acres. A miner having a pick-up width of 30 feet would be required to traverse 31.5 miles per day at a speed of 1.3 miles per hour or 115 ft per minute. It is assumed for the purpose of this study that there will be available a scraper type vehicle which would be remotely controlled by an operator in a submerged central control habitat to which the mining vehicle is linked by a short power line. The mining pattern would be rectangular, the scraper vehicle traversing back and forth in a direction normal to the direction of movement of the control habitat. On each return traverse, the scraper would dump its load into a hopper in the habitat structure, from where it would be pumped to the surface.

Table 3
PROFITABILITY ANALYSIS

	Norton Sound	Sheltered Coast
1. Sales		
Table II (75 cents/yd^3 90 per cent recovery)	5,460,000	10,580,000
2. Expenses		
Administrative (10 per cent sales)	546,000	1,058,000
Royalties		
Operating costs	1,852,600	2,585,700
Development capital (1/15 rate)	70,500	70,500
	2,969,100	3,714,200
3. Profit before taxes	2,991,900	6,765,800
4. Depletion allowance (15 per cent net sales)	820,000	1,585,000
5. New taxable income	2,171,900	5,180,800
6. Taxes 52 per cent net taxable	1,118,000	2,695,000
7. Net profit (item 3–item 6)	1,873,900	4,070,800
8. Capital (Table 1)		
Equipment	32,250,000	32,250,000
Development	1,058,000	1,058,000
Working	1,431,150	1,611,425
	34,739,150	34,922,425
9. Annual per cent ROI		
$\frac{\text{item 7}}{\text{item 8}} \times 100 =$	5.4 per cent	11.7 per cent

Detailed design criteria are not examined for the mining vehicle but no major problems are anticipated. Visual control of the mining operation would be possible using sonar transponders on the vehicle and at fixed locations within the deposit. Power distribution, controls and monitoring of the submerged equipment would be handled within the habitat.

The mining system would involve eight components: the deposit, a mining vehicle, a central control habitat, a hydraulic hoist or pumping system, a floating surface station, a deep submerged personnel transport and work vehicle, a surface transportation fleet, and an offloading and reduction plant onshore. Power requirements for the system are listed in Table 4.

–The central control habitat. This would incorporate a pump feed hopper, pump controls, and the first pumping stage. Power is supplied from the surface station and distributed to the mining vehicle, the hopper feeder, the first stage pumps, the habitat mobile functions, and the habitat itself. The habitat would be capable of continuous life support at one atmosphere and would be maintained by the deep submersible vehicle. Forward and lateral movement of the habitat at speeds up to 1.5 miles per hour would be necessary. Ground pressure could be adjusted within limits by ballasting. Recovery of the habitat would be effected, as with the miner, by the attachment of flotation sacks.

–The hydraulic hoist. Several investigations in the past have shown the feasibility of pumping solids from depths of 15,000 feet. No major design problems are foreseen that cannot be solved by

Table 4
POWER REQUIREMENTS

	Horsepower	Cumulative total horsepower
Mining Vehicle		
Product disposition	250	
Vehicle movement	750	
	1,000	1,000
Control habitat		
Auxiliary services	50	
Vehicle movement	500	
	550	1,550
Hydraulic Hoist		
Pump system	12,000	13,550
Floating platform		
Loading facilities	250	
Auxiliary services	500	
Positioning	1,000	
	1,750	15,300
Support submersible	500	15,800
Transport 4 barges	1,000	
4 tugs	8,000	
	9,000	24,800
Onshore reduction plant	5,500	30,300

state-of-the-art pipeline design practices. Stage pumping with the pumps located in buoyancy chambers at intervals has been proposed.

–The floating surface station. Ideally, this station will contain the power generator plant, maintenance plant (including a hoist of sufficient capacity to install and remove the pipeline), living quarters, deep submersible station, storage capacity for fuel and possibly for at least one barge load of ore. The station should have facilities to transfer ore into the barges from the production line and dynamic positioning to maintain station directly over the submerged habitat at all times. It should be designed to work in all weather and maintain stability. A spar buoy type hull to support the required facilities, constructed of reinforced concrete, is proposed but detailed design studies have not been carried out.

–The deep submergence personnel transport. This vehicle would be used to transport crews between the habitat and the surface in the manner of the Navy Deep Submersible Rescue Vessel. It would also be required to carry out routine maintenance on the submerged equipment. Of all the components of the mining system this would be the most sophisticated, but it is anticipated that the transport will become available as fall out from other development programs.

–Surface transportation. Because of lower cost compared with self propelled cargo vessels, and because superior maneuverability, a tug and barge combination was chosen to transport the ore from the mine site to shore. Self-unloading barges of 20,000-ton capacity are now in regular use, and speeds of eight knots may be maintained in the open sea with tugs of 2,000 horsepower. To maintain an annual production of 1.5 million tons, 75 round trips each of 18 days' duration will be required. Allowing for regular drydocking, this schedule could be maintained with four barges and their respective tugs.

–Onshore reduction plant. It has been shown experimentally that a hot sulphuric acid leaching process might be economic for the extraction of contained metals in manganese nodules, where the lime content is low. Percentage extraction is about 90 per cent for the cobalt, nickel and copper in the form of sulphides, and about 50 per cent for the manganese as manganese oxide. Further reduction and refining may be carried out without significant loss of metal content using standard metallurgical processes. Total cost of the process including refining is estimated tentatively at $20 per ton.

Table 5
COST SUMMARY
CAPITAL AND OPERATING COSTS

	Procurement cost ($x1000)	Annual operating cost Per cent procurement		Total operating expense ($x1000)	Operating cost $/ton
		Depreciation	Other		
1. Mining vehicle	1,000[1]	20	50	700	
2. Control habitat	3,000[1]	6.6	25	950	
Power and control	1,000[1]	10	25	350	
3. Hydraulic hoist	3,600[2]	10	50	2,160	
4. Floating surface station	6,500[2]	6.6	8.5	1,200	
5. Deep submerged transport	3,000[1]	6.6	10	500	
	18,100			5,860	3.86
6. Transport					
4 barges 20,000 T	16,000[3]	6.6	25		
4 tugs 2,000 HP	3,000[3]	6.6	25		
	19,000			6,000	4.00
7. Onshore reduction and refining plant	55,000[4]	6.6	47.4	30,000	20.00
Total	92,100			41,810	27.86
Development capital					
Property evaluation	5,000				
Equipment development	10,000				
Grant total	107,100				

[1] Unpublished MMTC source.

[2] Unpublished industry source.

[3] *Maritime Reporter and Engineering News,* 1967, June 1, p. 36, Aug. 15, p. 6.

[4] Unpublished Bureau of Mines source.

–Economic Analysis. Grade and values of the deposit are:[3]

Metal content	*Percentage*	*Gross lbs/ton*	*Recoverable lbs/ton*	*Unit value*	*Total value*
Ni	1.4	28	25.2	0.91	$22.95
Cu	1.4	24	21.6	0.50	10.80
Co	0.25	5	4.5	1.85	8.32
Mn	24.0	480	240	0.032	7.70
Total					$49.77
Total metal value Ni/Cu/Co					$42.07

Procurement and operating costs are shown in Table 5, which contains a number of assumptions because of lack of factual information. In each case, the assumptions are based on sound engineering judgment and experience, but it is stressed that considerable detailed engineering study would be required to confirm any of the estimates made and the estimates should be accepted only with this reservation.

–Development Capital. In allowing for development capital it is assumed that major development has been undertaken under other auspices for the floating platform, the support submersible, and the control habitat.

Table 6

PROFITABILITY ANALYSIS[1]

1. Sales	
Ni/Cu/Co/Mn content	
1.5 million tons @ $49.77	$ 74,655,000
2. Expenses	
Administrative (10 per cent sales)	7,466,000
Royalties (5 per cent sales)	3,733,000
Operating costs	41,810,000
(plus 1/15 development capital)	1,000,000
	54,009,000
3. Profit before taxes	20,546,000
4. Depletion allowance (15 per cent of item 3)	3,080,000
5. Net taxable income	17,466,000
6. Taxes (52 per cent net taxable income)	9,080,000
7. Net profit (item 3 - item 6)	11,466,000
8. Capital	
Procurement	92,100,000
Development	15,000,000
Working (25 per cent operating)	10,452,000
	$117,522,000

9. Annual percent ROII = $\frac{\text{(item 7)}}{\text{(item 8)}} \times 100 = 9.8$ percent

[1] Rounded to nearest $1,000.

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[3] From *Metal Markets,* January 1968.

Total development costs for these items would probably be near the $50-100 million range, and if included in the return on investment, they would reduce it to a quite unrealistic figure.

–Profitability Analysis (Tables 6 and 7). This illustrates in standard manner the estimation of the annual return on initial investment (ROII). Analysis is made of two cases with and without manganese included in the sales of product. Returns of 9.8 and 5.2 per cent are indicated. Standard percentage rates are used for administrative and selling expense, royalties, taxes and depletion allowance, and working capital, although it is not clear just how domestic taxation and allowances would apply to a high seas operation of this nature.

For the amount of capital involved, even the better case is considered marginal. However, considering the conceptual nature of the estimates, the possibility of improving on the economics of such an operation should not be dismissed.

Table 7
PROFITABILITY ANALYSIS[1]

1. Sales	
Ni/Cu/Co content, Mn discarded	
1.5 million tons @ $42.07	$ 63,105,000
2. Expenses	
Administrative (10 per cent sales)	6,311,000
Royalties (5 per cent sales).	3,155,000
Operating costs	41,810,000
(plus 1/15 development capital)	1,000,000
Total expenses	52,276,000
3. Profit before taxes	10,829,000
4. Depletion allowance (15 per cent of item 3)	1,625,000
5. Taxable profits	9,204,000
6. Taxes (52 per cent taxable profits)	4,790,000
7. Net profit (item 3 - item 6)	6,039,000
8. Capital	
Procurement	92,100,000
Development	15,000,000
Working (25 per cent operating)	10,452,000
Total capital	$117,552,000

9. Annual per cent ROII = $\frac{\text{(item 7)}}{\text{(item 8)}} \times 100 = 5.2$ per cent

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[1] Rounded to nearest $1,000.

FINDINGS AND RECOMMENDATIONS

Petroleum and natural gas will be critical components of the energy needs of our country throughout the foreseeable future. The continental margins of the United States offer an important opportunity to increase significantly our domestic reserves of these fossil fuels and to help offset the forecasted widening gap between domestic demand and production.

These marine resources can continue to be developed economically and efficiently provided that reserves of sufficiently large size continue to be found and that administrative policies recognize the greatly increased cost of working in the oceans. The system of competitive sealed-bidding has served well for assigning offshore drilling and production rights.

It is possible that added incentives or administrative changes will be necessary if we are to encourage early exploration and production in the deeper waters and more remote areas offshore. Examples might include an increase in the primary lease term and lease size, and a reflection in higher production rates of the very high cost of developing such areas.

A. Resource Management

It is difficult for many companies to maintain a broad base in exploration and production activities with the large budgetary and manpower commitments presently imposed by the irregular offshore lease sales.

Recommendation:

A firm schedule of lease sales, fairly evenly spaced and with more advance notice than at present, would permit more orderly, longer range planning by the industry. Within limits dictated by its own need for flexibility, the Federal Government should provide such advance information.

Proposals to set aside large areas of the ocean for single-use purposes, such as marine wilderness reserves, drilling sanctuaries, or Defense-restricted areas, may unnecessarily and without real justification restrict the development of nationally valuable marine resources. It is recognized, however, that single use areas reserved for scientific inquiry, preservation of unique species, or unique scenic value may be optimal.

Recommendation:

Due consideration should be given to the total resource potential of a given area before it is set aside for any single specific use. Additional cooperation and understanding between industry and the Federal and State governments are necessary to facilitate the multiple-use approach to all offshore areas.

B. Legal

There appear to be three basic areas of legal problems: Federal-State jurisdiction, seaward extension of international boundaries, and seaward limits of national jurisdiction.

State-Federal jurisdictional problems have in the past seriously delayed effective development of marine resources, and some disputes still continue.

Recommendation:

The continuing efforts to solve Federal-State offshore jurisdictional problems by negotiation or court settlement should be accelerated.

The lack of negotiation to determine the location of our borders with adjacent nations on our continental margins has not yet affected marine resources development; however, there is no doubt that it will become important in the near future.

Recommendation:

The Federal Government should determine as soon as possible the seaward boundaries between the United States and adjacent nations.

The continental slopes and rises adjacent to our Continental Shelf may contain potentially valuable reserves of oil and gas.

Recommendation:

An international legal regime is needed that will provide protection for the petroleum explorer in waters seaward from the 200 meter isobath. A regime that the panel believes to be satisfactory is described in detail in the report of the International Panel.

C. Technology and Research

The U.S. petroleum industry has developed a unique and successful technology for working at sea, and future development of this technology is continuing. Major advances in our ability to develop our marine petroleum resources do not appear to be dependent on developments outside the industry. Technology developed by Federal agencies for their own purposes (such as the Navy's satellite navigation system) can be of supplementary value to offshore oil and gas operations.

Recommendation:

The timely release and interchange of technological and research data between the Federal Government and the petroleum industry should be improved. A committee of appropriate agency and industry representatives should be formed to determine the most expeditious means for release and dissemination of such information.

D. Environmental Data and Forecasts

Environmental data related to sea conditions and weather are obviously important to marine petroleum operations, and to all others working in the oceans. Studies of historical conditions, the inter-relation between sea and air, and future forecasts are of particular importance. The increasing number of production platforms for offshore oil and gas provide an important basis for synoptic studies of sea and air conditions and should be utilized wherever practical. Eventual control of major storms could be of considerable value to petroleum production operations in the Gulf of Mexico, as well as to all others operating at sea in this area and off the Atlantic seaboard.

Recommendation:

The study of important sea-state and weather characteristics, such as directional waveheight and frequency spectra, wave data in severe storms, and large storm recurrence characteristics, should be accelerated. Forecast needs include wind, wave and sea-state predictions, and storm-track predictions. Studies in the control of major storms should continue.

E. Mapping and Surveys

A broad understanding of the surface topography of our continental margins and the nature of the overlying water mass are important to industry in its search for oil and gas accumulations, to the Federal and State governments in their administration of marine resources, and to science and the general public in increasing our understanding of these offshore areas. Bathymetric and navigation charts provided by government are of value in most work done in the oceans.

Recommendation:

The navigation charts traditionally prepared by the Government should continue to be updated on a timely basis. In addition, the general bathymetric mapping of the adjacent continental shelves, slopes, and rises by the Federal Government should continue as at present or at greater levels of activity.

It appears that reconnaissance geologic studies of our continental margins are actively being pursued by industry. Surveys and studies directed toward finding undiscovered petroleum resources are being adequately handled at present by industry. However, because of the competitive nature of petroleum exploration, the high cost of working at sea, and the large investments under present lease acquisition procedures, the data collected by industry will be added to public knowledge very slowly.

Recommendation:

Broad reconnaissance geological studies of our continental margins, supported by the Federal Government, should continue in order to add to scientific knowledge and to provide a knowledgeable basis for administering resource development. The Government should not support or undertake detailed surveys or other studies which industry is already equipped and willing to do at its own expense.

Most of our understanding of the basic geology of continental margins and other marine areas has resulted from the surveys made by oceanographic and other academic institutions. Such studies are distinct from the systematic Federal surveys discussed above, since they are devoted normally to solving specific problems in marine geology.

Recommendation:

The marine geological and geophysical surveys and scientific studies historically conducted by oceanographic and other academic institutions should continue to be actively supported through Federal funding.

I. INTRODUCTION

A. Fossil Fuels in the U.S. and World Economy

A recent report to the President by a special interagency study group[1] points out that the incremental cost of energy is remarkably low in comparison to its value to society. In fact, the cost of energy was considered to be so small that its value to the economy of the United States was extremely difficult to measure quantitatively. This report noted that:

the total cost of fuels and electricity is only a miniscule percentage of the value added by manufacture for most major industrial groups, and for only a few of them is it as much as several percent.

This report concluded:

The pervasive significance of energy in the national economy is readily demonstrable, yet it is not revealed in the statistics that ordinarily measure the economy. Energy is not a large item of expense for either the individual or the economy as a whole. While it does not determine the cost of a razor blade, an article of clothing, a piece of machinery, or a house, these goods would not be available at their selling prices–nor in some instances, at any meaningful price–without an ample supply of energy. In the final analysis, energy is not only essential but irreplaceable.[2]

Another measure of the relationship between energy and economic well-being was also noted by this same interagency panel:[3]

The United States, with the highest per-capita energy consumption in the world, has also the highest standard of living and the largest output of goods and services as measured by the gross national product. Figure [1] indicates that high energy-consumption levels and high income levels go hand in hand–in fact, all studies of the subject find a close connection between per-capita energy consumption and the standard of living.

The United States presently consumes about 35 per cent of the world's production of petroleum and approximately 62 per cent of the marketed natural gas. By far the largest part of the domestic petroleum consumption is devoted to transportation (54 per cent), while household and commercial consumption would rank second (20 per cent), followed by industrial uses (11 per cent). The non-energy use of petroleum as a raw material (petrochemicals) has already grown to about 10 per cent (Table 2). Most of the domestic natural gas is devoted to industrial use (45 per cent), which together with household and commercial consumption accounts for 80 per cent of all natural gas purchases in the United States. These are expected to remain the major users of oil and gas for at least the next 35 years (Table 3).

The value at the well-head of all domestic petroleum and natural gas produced in 1966 was approximately $13 billion. During that year, U.S. oil companies spent about $15 billion throughout the free world, about half of which was spent domestically (including nearly $5 billion on exploration and production). At these present rates of expenditure it has been estimated[4] that if the free world demand by 1990 will be about two and one-half today's volumes, as projected, a capital investment will be required over the preceding 25 years of about $350 billion. The petroleum industry requires vast amounts of investment capital and in the past it has been largely self-financing, but meeting these future capital requirements, especially for the very expensive marine opera-

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[1] Ali B. Cambel, *Energy Research and Development and National Progress* (Washington, D.C.: U.S. Government Printing Office, 1966), pp. 1-6.

[2] *Ibid.*, p. 4.

[3] *Ibid.*, pp. 2-3.

[4] John H. Loudon, "Oil's Future To Be Fascinating," *Oil and Gas Journal*, June 28, 1965, pp. 71-78.

Table 1

THE ENERGY BILL AS A PER CENT OF VALUE ADDED IN MANUFACTURING, MAJOR INDUSTRIAL GROUPS, 1961

Industry	Value added by manufacturing (thousand dollars)	Total cost of purchased fuels and electric energy (thousand dollars)	Energy bill, as per cent of value added
Food and kindred products	20,273,196	571,657	2.82
Tobacco products	1,515,608	9,261	.58
Textile mill products	5,613,161	212,019	3.78
Apparel and related products	6,697,239	50,339	.75
Lumber and wood products	3,422,991	139,564	4.08
Furniture and fixtures	2,551,925	39,647	1.55
Paper and allied products	6,661,655	433,908	6.51
Printing and publishing	9,491,960	79,835	.84
Chemicals and allied products . . .	14,767,606	925,071	6.26
Petroleum and coal products	3,438,052	362,239	10.54
Rubber and plastic products (not elsewhere classified)	3,929,023	112,231	2.86
Leather and leather products	2,041,979	28,717	1.41
Stone, clay and glass products . . .	6,335,635	546,592	8.63
Primary metal industries	12,982,436	1,277,072	9.84
Fabricated metal products	10,282,655	220,258	2.14
Machinery except electrical	14,154,945	228,881	1.62
Electrical machinery	13,758,559	180,159	1.31
Transportation equipment	16,801,578	283,402	1.69
Instruments and related products . .	3,918,076	39,330	1.00
Miscellaneous manufacturing	5,064,516	66,566	1.31
Total, all industries	163,801,084	5,806,749	3.55

Source: Department of Commerce, Bureau of the Census, 1961 Annual Survey of Manufactures, General Statistics for Industry Groups and Selected Industries M61(AS)–1, p. 4; Fuels and Electric Energy Used by Major Industry Groups, and by Divisions and States M61(AS)–5, p. 2.

tions, will be a major challenge. The industry's present offshore investment rate of about $1 billion per year is expected to exceed $25 billion over the next 10 years, in more than 100 countries.

The petroleum industry has already become a significant factor in the development of marine resources. Production has been established in the waters of 22 countries and exploration is now underway off the shores of more than 75 nations on five continents. Offshore drilling rigs are at work on the continental shelves of 35 countries, and 15 more are expected to join the list soon. Approximately 20 per cent (about 70 billion barrels) of the free world's proved petroleum reserves are offshore, and approximately 16 per cent (5 million barrels per day) are now being produced from offshore, as well as 6 per cent of the free world's gas production.

Already, more than $7 billion has been invested by the petroleum industry in the waters off the United States, and over 9,000 domestic offshore wells have been drilled. The annual income to the Federal Government from offshore petroleum is already about two-thirds of the total mineral royalties received by the Federal Government

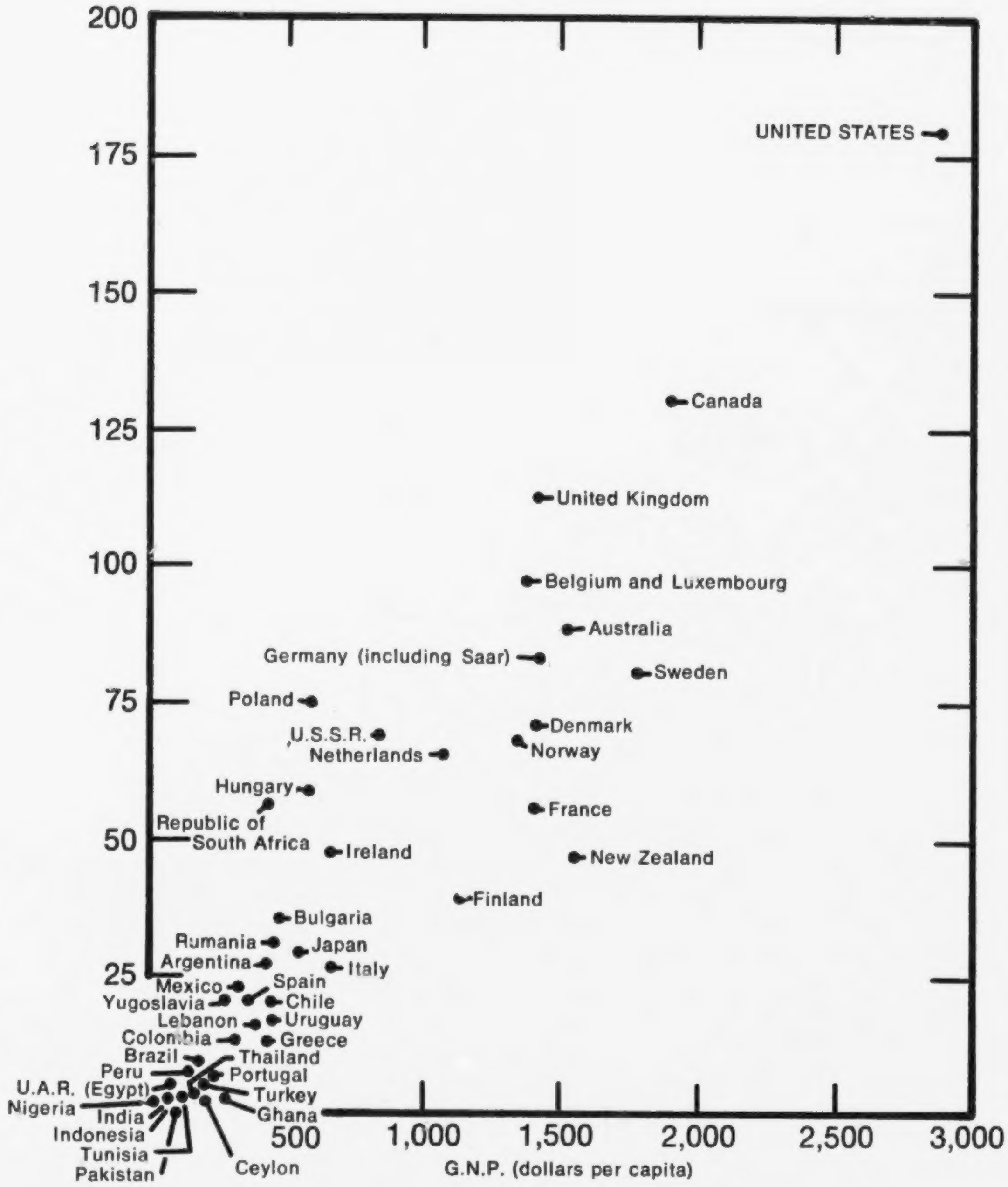

Figure 1. *Commercial energy consumption (millions of BTU per capita). Source: Ali B. Cambel,* Energy Research and Development and National Progress *(Washington, D.C.: U.S. Government Printing Office, 1966).*

from all sources, onshore and offshore, and about $6 billion in direct payments have been made to Federal and State treasuries for leasing rights and royalties.

B. Rate of Utilization of Fossil Fuels

The world is now in the midst of a tremendous surge in the demand for energy. The worldwide population boom, the rising standard of living in many places, and the international growth of industry all are contributing to a rapidly swelling appetite for energy. One recent projection estimates that during the next 20 years the energy demands of the free world are expected to grow from the present daily need of 62 million barrels of oil equivalent to 140 million barrels per day of oil equivalent.[5] Petroleum and natural gas are expected to meet about two-thirds of this need, requiring nearly two and one-half times as much daily oil production in 1987 as at present.

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[5] T. W. Nelson, *The Underwater Search for Oil and Gas, A Forum on Oceanography* (New York: Hayden-Stone, 1967).

Table 2
DOMESTIC DEMAND BY CONSUMING SECTOR FOR OIL AND GAS IN 1966

Sector	Petroleum		Natural Gas	
	Millions of Barrels	Per cent of total	Trillions of Cubic Feet	Per cent of total
Energy Uses:				
Transportation	2,340	54.1	0.5	3.2
Household and Commercial .	844	19.5	5.8	34.4
Industrial	472	10.9	7.6	45.2
Electric Utilities	143	3.3	2.6	15.5
Other	82	1.9	–	–
Raw Materials:				
Petrochemical Feedstock . .	207	4.5	0.3	1.7
Other	220	5.1	–	–
Miscellaneous and Unaccounted	17	0.4	–	–
Total	4,325	100.0	16.8	100.0

Source: Bureau of Mines.

Table 3
DOMESTIC DEMAND BY CONSUMING SECTOR, AS A PER CENT OF TOTAL CONSUMPTION FOR OIL AND GAS IN 1966 AND 2000

Sector	Petroleum		Natural Gas	
	1966	2000	1966	2000
Transportation	54	69	3	2
Household and Commercial[1] . .	24	3	35	45
Industrial[1]	17	26	46	43
Electric Utilities	3	1	16	10
Miscellaneous and Unaccounted	2	1	–	–
Total	100%	100%	100%	100%

Source: Bureau of Mines.

[1] Includes raw materials.

At this rate, the free world is expected to consume nearly 400 billion barrels of petroleum and 650 trillion cubic feet of natural gas during the next 20 years. This is about three times the total amount of these materials produced throughout the free world during the last 100 years (Table 4).

The special interagency study group mentioned previously[6] estimated that between 1960-2000, three-fourths of the domestic energy needs will have to be met by petroleum (44 per cent, or 240 billion barrels) and natural gas (31 per cent or 1,000 trillion cubic feet). These estimates are 470 per cent of the proved petroleum reserves at the start of this period and 330 per cent of the gas reserves.

One of the major remaining areas in which to search for these resources is in the submerged continental margins of the world.

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[6] Cambel.

Table 4
FORECAST OF FREE WORLD ENERGY DEMANDS BY COMPONENT FUELS
(in millions of barrels per day of oil energy equivalent basis'

Year	Petroleum	Natural Gas	Coal	Water Power	Nuclear	Other	Total
ABSOLUTE							
1950	10.1	3.0	14.8	2.1	–	0.7	30.7
1965 (est.)	25.9	8.6	15.6	4.1	0.2	1.1	55.5
1975 (est.)	40.1	14.1	18.4	5.8	1.8	0.8	81.0
1985 (est.)	56.6	22.2	21.4	7.6	7.6	0.6	116.0
PERCENTAGE OF DEMAND							
1950	32.9%	9.8%	48.2%	6.8%	–	2.3%	100%
1965 (est.)	46.7	15.5	28.1	7.4	0.4	1.9	100
1975 (est.)	49.5	17.4	22.7	7.2	2.2	1.0	100
1985 (est.)	48.8	19.1	18.4	6.6	6.6	0.5	100

Source: T. W. Nelson, "A Twenty Year Look at Free World Petroleum Requirements—A 330 Billion Barrel Challenge," Journal of Petroleum Technology, 1965.

1. Petroleum

World demand for petroleum (crude oil and natural gas liquids) in 1966 was 12.5 billion barrels, according to the Bureau of Mines, with approximately the following pattern of consumption:

United States	–	35 per cent
Other North America	–	5 per cent
Latin America	–	5 per cent
Europe	–	28 per cent
U.S.S.R.	–	12 per cent
Africa	–	2 per cent
Middle East	–	2 per cent
Far East	–	11 per cent

Domestic consumption in 1966 was 4.3 billion barrels of petroleum, accounting for approximately 43 per cent of the total energy used within the United States.

Unofficial estimates by the Bureau of Mines predict that worldwide annual petroleum consumption will increase 120 per cent by 1980, and 335 per cent by the year 2000 when the requirement will be about 42 billion barrels per year. Cumulative world requirements during the 1966-2000 period would total about one trillion barrels of petroleum. Domestic requirements during this interval will total approximately 290 billion barrels. The total production of domestic petroleum to the end of 1966 is about 81 billion barrels.

Although petroleum is expected to provide a smaller share of the domestic future energy requirements (from more than 40 per cent now to about 35 per cent in 2000), the consumption of petroleum will continue to increase each year, as the total demand for energy continues to grow. During 1966 imports accounted for about 20 per cent of domestic petroleum consumption. The total volume of imports and the relative percentage is expected by many observers to continue to increase.

2. Natural Gas

Most of the natural gas produced outside of the United States is solution gas recovered with the crude oil. Approximately 75 per cent of this is utilized locally in the field, or all of it is flared. A total of 27.7 trillion cubic feet (tcf) of natural gas was marketed throughout the world in 1966, according to the Bureau of Mines, in approximately the following pattern of consumption:

United States	—	62 per cent
Canada	—	5 per cent
Europe	—	9 per cent
U.S.S.R.	—	19 per cent
Rest of world	—	5 per cent

Domestic consumption in 1966 was 17.2 tcf of dry natural gas (natural gas liquids were included previously with petroleum for about 15 per cent of the total energy used within the United States).

Unofficial information by the Bureau of Mines predicts that worldwide annual consumption of natural gas by the year 2000 will increase by 225 per cent, requiring about 124 tcf of gas per year. These projections assume that the development of cryogenic tankers for transporting liquefied natural gas will make it competitive in major world markets. The annual domestic demand for dry natural gas in the year 2000 will amount to more than 40 tcf per year, a demand approximately two and one-half times greater than in 1966. The cumulative domestic demand during the 1966-2000 period may total 900 trillion cubic feet.

III. RESERVES OF OIL AND NATURAL GAS

The total volume of oil or gas in any local accumulation is commonly known as petroleum "in place." The amount of this that can be recovered depends largely on three factors:

–Physical. The nature of the reservoir rock, the type and composition of the petroleum, and the source of pressures within the reservoir;

–Technologic. The engineering techniques available for drilling and producing the petroleum under a variety of adverse conditions;

–Economic. The cost of exploring, drilling, producing, and transporting the petroleum as compared with its value or market price.

The volume of recoverable petroleum in any reservoir, subject to all these conditions at any particular time, is known as the "recoverable reserves," or simply the "*reserves*." Thus, reserves represent a working inventory of petroleum which changes with time, technology, and economic conditions.

Obviously, the volume of oil or gas already recovered from a reservoir is the most accurately known component of the eventual total oil recovery. Some of the reserves remaining in the ground can be estimated fairly accurately by data from drilled wells; these are considered to be "*proved reserves.*" Less accurate are estimates of recoverable reserves in undrilled parts of the reservoir and added reserves that might become available by improved recovery techniques that have not yet been tried; these are known as "prospective reserves." The least accurate estimates are of reserves in accumulations that have not yet been found or reserves that might be recoverable with some future technology. These are "speculative reserves," and obviously they are most speculative in regions where there has been no drilling.

The uncertainties of insufficient knowledge and changing economic and technologic conditions will always be with us. Neither a final inventory nor a firm forecast of ultimate production is possible. Estimates by various specialists vary greatly, especially in the categories of prospective and speculative reserves. The total world production and the proved reserves remaining at the close of 1967 are shown in Table 5.

At the present time the free world has adequate proved reserves to supply its needs in petroleum for about 36 years at the present rate of consumption. The proved reserves in North America are about 11 times greater than present annual production. The Arab nations in the Middle East and North Africa have about 75 per cent of the free world's proved reserves; and while North America consumes about 45 per cent of the free world's petroleum production, it has only about 13 per cent of the proved reserves (Table 5).

A. Supply Prospects from Domestic Sources

McKelvey[7] has recently summarized various reserve estimates for petroleum and natural gas in the United States. The tabulations suggest generally that at the close of 1966 the United States had about 34 billion barrels of proved petroleum reserves, and 7 to 17 billion prospective barrels that might be obtained by improved recovery techniques. An additional 20 to 40 billion barrels of speculative reserves might be recovered by future technologic advances or more favorable economic conditions (Table 6). Estimates of speculative undiscovered reserves are rare and their

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[7] V. E. McKelvey, *Contradictions in Energy Resource Estimates*, Seventh Biennial Gas Dynamics Symposium (Northwestern University, 1967).

Table 5
WORLD-WIDE OIL AND GAS RESERVES AND PRODUCTION

Area	Reserves: Oil (1000 bbl)	Reserves: Gas (billion ft^3)	Wells: Oil Prod.	Wells: Oil Production Est. 1967 (1000 bbl)
ASIA-PACIFIC				
Indonesia	9,000,000	2,500	2,244	504.8
India	1,638,000	1,500	643	113.0
Other	1,177,945	36,950	1,817	169.9
Total Asia-Pacific	11,815,945	40,950	4,704	787.7
EUROPE				
W. Germany	710,000	8,500	3,390	157.0
Netherlands	331,000	82,000	379	45.5
Italy	300,000	5,500	132	38.0
Other	675,000	37,965	1,730	153.0
Total Europe	2,017,000	133,965	5,631	393.5
MIDDLE EAST				
Saudi Arabia	74,700,000	35,000	362	2,570.5
Kuwait	70,000,000	34,500	503	2,276.7
Iran	43,800,000	109,500	163	2,575.0
Other	61,709,000	41,670	1,059	2,524.7
Total Middle East	249,209,000	220,670	2,087	9,946.9
AFRICA				
Libya	29,200,000	15,000	734	1,716.9
Algeria	6,900,000	140,000	701	811.7
Other	6,185,250	12,000	803	603.4
Total Africa	42,285,250	167,230	2,237	3,132.0
WESTERN HEMISPHERE				
United States	37,541,000	292,596	698,958	8,800.9
Venezuela	17,000,000	31,770	10,547	3,537.0
Canada	8,791,750	48,000	20,947	972.4
Other	9,907,250	35,243	17,626	1,318.7
Total Western Hemisphere	73,240,000	407,679	748,078	14,629.0
TOTAL FREE WORLD	378,567,195	969,605	762,737	28,889.1
Communist Areas	35,773,000	215,500	(Virtually all oil & gas is in USSR)	6,239.0
TOTAL WORLD	414,340,195	1,185,105	—	35,128.1

Source: Oil and Gas Journal, Dec. 25, 1967.

Table 6
SOME ESTIMATES OF TOTAL DOMESTIC CRUDE OIL RESOURCES
(in billions of barrels)

	In Known Fields					In Undiscovered Fields
	Proved			Probable	Possible	
	IOCC	API	C&GJ	Hendricks		
Recoverable[1]	32.1 +17.7	31.4 (+7.5)	36.1	40		Not Estimated
Marginal[2]	21.6					
Submarginal	+39.8					
Originally in place	404	(381)		100		
Total Originally in place				Hendricks 1600		
Ultimate Production	Hubbert 160-200	Moore 296-434		Hendricks 400	Weeks 430	

Source: V. E. McKelvey, *Contradictions in Energy Resource Estimates,* Seventh Biennial Gas Dynamics Symposium (Northwestern Univ. preprint, 1967).

[1] Proved reserves, plus possible additional by conventional secondary recovery techniques.

[2] Possible reserves available to conventional, but uneconomic secondary recovery, plus possible reserves from techniques not perfected.

range is great; estimates of ultimate total production in the United States, for example, range from less than 200 to more than 400 billion barrels of petroleum. It is not possible to attribute the share of these estimated prospective or speculative reserves to onshore or offshore areas.

Estimates of domestic natural gas reserves are more difficult to make and consequently are fewer in number. McKelvey[8] evaluates two estimates of ultimate gas production, each about 1,800 trillion cubic feet.

There is no scarcity of foreign oil to supplement domestic production, but the historic policy of the United States has been that it cannot afford to become excessively dependent in the short term on foreign oil imports.

An indication of the future supply problem confronting the United States is that if we consume 83 billion barrels of petroleum between now and 1980, as projected, this would amount to an average of more than 5.5 billion barrels per year. By contrast, the largest addition to U.S. reserves was 4.4 billion barrels in 1959, and the average for the past eight years has been 3.5 billion barrels annually. Also needed will be 450 trillion cubic feet (tcf) of gas, or an average of 30 tcf per year. Industry has never added more than 25 tcf of reserves in any year and the average over the last two years was 21 tcf.

While proved reserves have grown over the last 20 years from about 21 to 31 billion barrels, production has also grown from 1.7 to 3.5 billion barrels per year, and the ratio between reserves and annual production has dropped from a high of nearly 13 in 1960 to less than 10 at the present time (Table 7). Domestic exploratory drilling in 1968 is down 50 per cent from its peak in 1956.

Technological developments, economics, and governmental policies will also determine to what extent future U.S. demand is to be met from domestic oil and gas resources, from imports or from alternate sources (oil shale, coal, tar sands).

B. Supply Prospects from Domestic Offshore Areas

In discussing the petroleum resources of our continental margins, a definition is required of the bathymetric areas. The earth consists essentially of two great topographic surfaces: The general eleva-

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[8] *Ibid.*, p. 21.

Table 7
NORTH AMERICA'S DECLINING OIL SUPPLY

	UNITED STATES			NORTH AMERICA		
Year	Proven Reserves (000,000 bbls.)	Production (000,000 bbls.)	Reserves– Life Index	Proven Reserves (000,000 bbls.)	Production (000,000 bbls.)	Reserves– Life Index
1946	20,873.6	1,726.3	12.1	20,873.6	1,726.3	12.1
1951	27,468.0	2,214.3	12.4	20,844.6	2,261.6	12.8
1955	30,012.2	2,419.3	12.0	32,521.7	2,546.8	12.8
1959	31,719.3	2,483.3	12.4	35,216.4	2,667.0	13.0
1960	31,613.2	2,471.5	12.8	35,291.7	2,662.6	13.2
1961	31,758.5	2,512.3	12.3	35,932.1	2,733.3	13.2
1962	31,389.2	2,550.2	12.3	35,869.9	2,795.1	12.8
1963	30,970.0	2,593.3	11.9	35,861.5	2,849.8	12.6
1964	30,990.5	2,644.2	11.7	37,168.2	2,915.0	12.7
1965	31,352.4	2,686.2	11.7	38,063.6	2,977.8	12.2
1966	31,452.1	2,864.2	10.9	39,243.9	3,180.2	12.3
1967[1]	31,443.0	3,214.6	9.8	39,643.0	3,556.4	11.1

	CANADA		
Year	Proven Reserves (000,000 bbls.)	Production (000,000 bbls.)	Reserves– Life Index
1946	NA	NA	NA
1951	1,376.6	47.3	29.1
1955	2,509.5	127.5	19.9
1959	3,497.1	183.7	19.0
1960	3,678.5	191.1	19.2
1961	4,173.6	221.0	18.9
1962	4,480.7	244.9	17.9
1963	4,481.5	256.5	19.0
1964	6,177.7	270.8	22.7
1965	6,711.2	291.6	23.0
1966	7,791.8	316.0	24.6
1967[1]	8,200.0	341.8	23.7

Source: *Oilweek,* Feb. 19, 1968

[1] Preliminary estimates.

tion of the continents, slightly above sea level, and the great depths of the ocean basins. The boundaries between these two regions comprise the continental margin of the world. The volume of water in the oceans slightly exceeds the capacity of the ocean basins, with the result that the edges of the continents are slightly under water (Figure 2).

The gently sloping sea floor adjacent to the shoreline is known topographically as the "continental shelf," and its outer edge is normally marked by an increase in slope, known as the "shelf edge." By convention the edge the shelf is considered to approximate a water depth of about 100 fathoms or 200 meters (since one or the other of these isobaths is normally plotted on most bathymetric charts), but in fact it ranges from less than this depth to much more. The steeper surface beyond the shelf is the "continental slope." The more gentle surface beyond the slope is the "continental rise," which extends down to the average depth of the ocean basins at about 2,500 fathoms or 5,000 meters. The shelf, rise, and slope together make up the idealized "continental margin."

However, many continental margins vary significantly from the idealized configuration just described (Figure 3). Each of these many variations is the result of a different geological history, and each area poses distinct problems for the exploration and development of its oil and gas resources, as well as for any reasonable estimate of the speculative reserves it might contain.

Approximately two billion barrels of petroleum and five and one-half trillion cubic feet of natural gas had already been produced from the U.S. continental shelves by early 1966, and another three and one-half billion barrels and 22-3/4 trillion cubic feet had been proved by drilling.[9] The known energy resources beneath our continental shelves at that time thus amounted to

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[9] T. W. Nelson and C. A. Burk, *"Petroleum Resources of the Continental Margins of the United States,"* in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966).

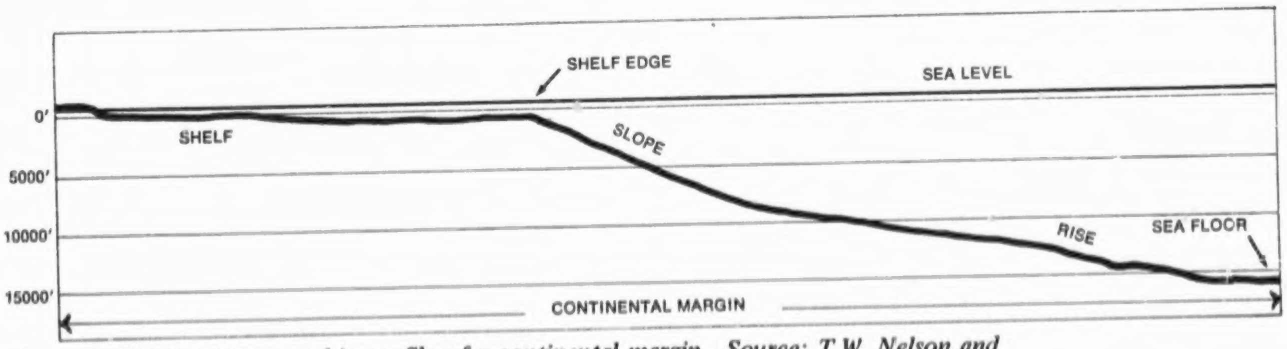

Figure 2. *Idealized topographic profile of a continental margin. Source: T.W. Nelson and C.A. Burk, "Petroleum Resources of the Continental Margins of the United States," in* Exploiting the Ocean *(Washington, D.C. 20005: Marine Technology Society, 1966).*

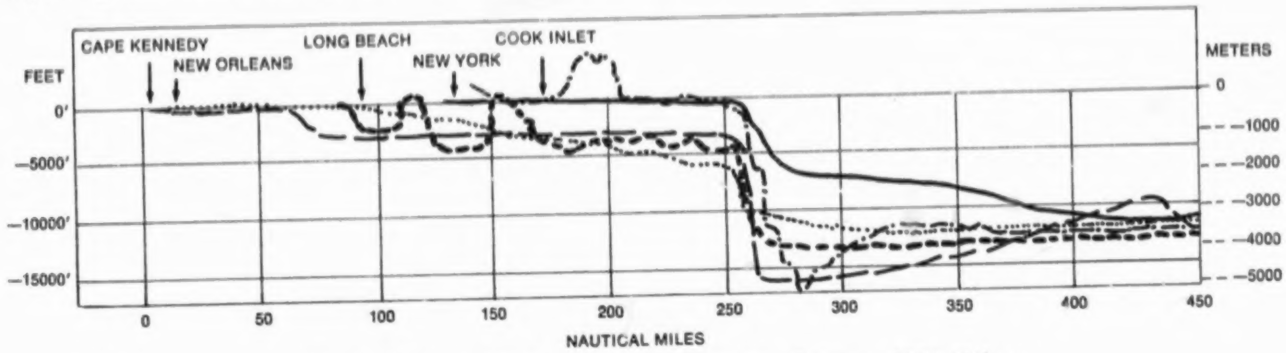

Figure 3. *Topographic profiles and areas of U.S. continental margins. Source: T.W. Nelson and C.A. Burk, "Petroleum Resources of the Continental Margins of the United States," in* Exploiting the Ocean *(Washington, D.C. 20005: Marine Technology Society, 1966).*

TOPOGRAPHIC PROFILES AND AREAS OF U.S. CONTINENTAL MARGINS

	Water Depth and Area (In Thousand Miles^2)			
	0-200M	200-1,000M	1,000-2,000M	Total
Atlantic Margin	124	28	12	164
Florida Margin	78	51	18	147
Gulf of Mexico	68	27	33	128
(Louisiana)	(25)	(10)	(10)	(45)
Pacific Margin	23	27	26	76
Alaska Pacific	82	29	13	124
(Gulf of Alaska)	(25)	(7)	(3)	(35)
Aleutian Shelves	16	28	28	72
Bering Sea Shelf	364	10	10	384
(Bristol Bay)	(50)	(1)	(1)	(52)
Artic Margin	120	55	100	275
Total	875	255	240	1,370

Source: T. W. Nelson and C. A. Burk, "Petroleum Resources of the Continental Margins of the United States," in *Exploiting the Ocean* (Washington, D. C.: Marine Technology Society, 1966).

slightly more than five and one-half billion barrels of oil and 28 trillion cubic feet of gas (the remaining proved reserves offshore at that time amounted to about 10 per cent of the total known U.S. oil and gas resources).

Nelson and Burk[10] also compiled and discussed previous estimates of the ultimate oil and gas resources (Table 8) and presented evaluations of

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[10] *Ibid.*

Table 8
PUBLISHED ESTIMATES OF OFFSHORE PETROLEUM RESOURCES

ULTIMATE OFFSHORE OIL AND N.G.L. RESERVES
(billions of barrels)

	Atlantic Coast	Calif.	Gulf Coast	United States	North America	World
Pratt, 1947				(33)		1,000
Weeks, 1950						400
U.S.G.S., 1951, 1954		2	13	>15		
Egloff, 1952				(50-100)		(500-1,000)
Schultz, 1952				<30		
Carmical, 1955				>15		
Hubbert, 1956				20		
Atwater, 1959			>3.5(La.)			
Johnston, *et al.*, 1959	7.7					
Hubbert, 1962, 1965				(25)		400
Weeks, 1965					(137)	700
Rubel, 1966		>7				

ULTIMATE OFFSHORE NATURAL GAS RESERVES
(trillions of cubic feet)

	Atlantic Coast	Calif.	Gulf Coast	United States	North America	World
Terry, 1950				50		
U.S.G.S., 1954		3.5	65	68.5		
Kastrop, 1955			(70)			
Hubbert, 1956				(150)		
Atwater, 1959			>21.5(La.)			
Johnston, *et al.*, 1959	46.2					
Hubbert, 1962, 1965				(125-150)		
Weeks, 1965					(348)	(1,740)

RECENT ESTIMATES OF TOTAL RESOURCES

	U.S. Total		World Total	
	Oil ($x10^9$ bbls.)	Gas ($x10^{12}$ ft.^{3})	Oil ($x10^9$ bbls.)	Gas ($x10^{12}$ ft.^{3})
Hubbert, 1962, 1965	205	1,000	1,500	7,500
Hendricks, 1965	460	2,000	(2,900)	(15,000)
Weeks, 1965 (Offshore only)			1,000	(1,740)

Source: T. W. Nelson and C. A. Burk, "Petroleum Resources of the Continental Margins of the United States," in *Exploiting the Ocean* (Washington, D.C.: Marine Technology Society, 1966).

their own based on geological extrapolations. They estimated that three billion barrels of petroleum and 27 trillion cubic feet of natural gas probably await drilling in reservoirs already known, and that possibly 8 to 26 billion barrels and 33 to 113 trillion cubic feet remain to be discovered.

The ultimate petroleum production from the U.S. continental shelves would thus be estimated to range from about 15 to 35 billion barrels of petroleum and from 90 to 170 trillion cubic feet of natural gas. For comparison, the total U.S. production for 1966 was three and one-half billion barrels and 17 trillion cubic feet. These estimates were not meant to be interpreted as limits (the actual production could be either greater or less), but merely as a range within which reasonable estimates could be made at that time based on reasonable geological extrapolations and interpretations.

The most recent exhaustive study of offshore domestic reserve estimates was made in 1968 by the Geological Survey for the Public Land Law Review Commission.[11] This report concluded that to the end of 1966 proved reserves of 4.3 billion barrels of petroleum and 31 trillion cubic feet of natural gas remained to be produced from the U.S. continental shelves, and that recoverable reserves might range from 35 billion barrels of petroleum and 170 trillion cubic feet of gas, as estimated by Nelson and Burk, to something approaching 180-220 billion barrels and 820-1,100 trillion cubic feet. Although the Geological Survey study covered the seabed to a depth of 2,500 meters, the resources beyond a depth of 200 meters were not considered to be recoverable now.

There is nearly an order of magnitude of difference between the reserve estimates in the two careful studies just noted, but as McKelvey *et al.* observe,[12] this is

> *a difference that may be frustrating if not unsettling to those who are unaccustomed to the uncertainties that inescapably accompany attempts to appraise potential mineral resources—however, an order of magnitude difference among such estimates is a good deal less than the range in the individual parameters involved, and the wonder is that the estimates agree so well.*

The estimate by Nelson and Burk considered only the continental shelves to water depths of 200 meters, while the Geological Survey report also included the continental slope to 2,500 meters of depth.

The earlier study by Nelson and Burk relied entirely on extrapolations and interpretations based on comparisons of the known geology of various offshore areas with the productive characteristics of similar onshore areas. The Geological Survey study compromised the results of two other types of approaches. One was purely statistical, based on the historical amount of oil found as related to the cumulative footage of drilling, and an assumption that all unexplored sedimentary rocks contain on the average half as much petroleum as those already explored by drilling. The second approach modifies the first by assigning "favorability factors" to various parts of the shelves according to their supposed similarity to well-known producing areas.

It is unlikely that anywhere near the density of wells will ever be drilled offshore as compared to the onshore, as is assumed in both Geological Survey approaches; the cost of drilling is much greater offshore, and many of the small fields now being developed onshore (accounting for a very large number of wells) could never be produced economically offshore. Also, the largest share of our domestic reserves is trapped in a relatively few giant-sized fields, which required only a relatively few wells for discovery. These and other factors tend to complicate such a purely statistical approach to estimates of undiscovered reserves, and also tend to make the results too high. In their second approach it would appear that the Geological Survey was much more optimistic in their geologic interpretations than were Nelson and Burk.

In this regard, such geological extrapolations cannot be done without tempering them with economic realities; as the depth of water increases so does the cost of developing the petroleum, as well as the minimum size of field that can be economically developed. Industry cannot afford to drill as many wells offshore as on land and find only the same amount of oil. It would appear that the Geological Survey estimates of ultimate offshore reserves must in practice be considered as overly optimistic (Table 9).

However, it is obvious that two major opportunities are available to increase our domestic reserves of oil and gas. One is by improving and developing methods to increase the amount of petroleum that can be recovered from fields already known, and the other is by exploring for oil in our virgin continental margins. Both of these approaches are being vigorously pursued by the petroleum industry, and the success to date has been significant.

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[11] V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

[12] *Ibid.*, p. 39.

Table 9
POTENTIAL U.S. AND WORLD PETROLEUM RESOURCES[1]

Area	Remaining Proved Reserves (billions of barrels) (trillions of cubic ft.)			Recoverable resources under current economics and technology (including cumulative production and proved reserves)		
	Crude oil	Natural gas	NGL	Crude oil	Natural gas	NGL
Total U.S.	31	286	8	547	2,737	82
Continental U.S.	27	255	7	367	1,838	55
U.S. Continental Shelves (Total)[2] . . .	4	31	1	180	900	27
Total World except U.S..	357	786	NA	1,575	13,250	355
Total World	388	1,073	NA	2,122	15,987	437

Source: Data drawn from V. E. McKelvey *et al.*, "Potential Mineral Resources of the United States Outer Continental Shelves," unpublished report of the Geological Survey to the Public Land Law Review Commission, March 1968.

[1] Calculated from data to Jan. 1, 1966.

[2] Continental shelves include State land or 0 to 2,500 meters isobath.

Any estimate of reserves in the outer and deeper parts of the continental shelves is necessarily very speculative, and estimates in the much deeper waters beyond the shelf are almost entirely subjective at the present time. Not only is the geology of these remote areas very poorly known, but there is also no way yet to make reliable estimates of the cost or efficiency of any technology that might eventually be developed to recover these resources.

The Continental Shelf and slope are essentially submerged parts of the continent, however, and there is no reason to expect the conditions for generation and entrapment of oil and gas to be significantly poorer on many continental slopes than farther landward. Continental rises are even more poorly known, but scattered data also suggest that at least some of the conditions conducive to petroleum generation and accumulation are present in many of these areas.

There is at present no way to estimate even the potential oil-in-place in these deeper waters, but U.S. petroleum companies are already conducting broad surveys and expensive studies beyond the continental shelf to improve their understanding of these areas. As an example, a recent study conducted jointly by four companies involved about 20,000 miles of geophysical surveys and nearly 60 core holes drilled beneath the sea floor to depths of 1,000 feet in water to nearly 5,000 feet deep. This investigation covered the continental slope, entirely beyond 600 feet of water, from near Brownsville, Texas, eastward across the Gulf of Mexico, along the eastern margins of Florida, and throughout the length of the eastern U.S. seaboard. This expensive study was conducted not to find specific accumulations of oil or gas, but to gather data which would allow a broader interpretation of the basic geological structure of the deeper parts of these U.S. continental margins (Figure 4).

The success of such modern far-sighted approaches in developing areas is perhaps best indicated by the fact that while the barrels of oil onshore discovered per foot of exploratory drilling has declined from about 50 barrels 25 years ago to 44 barrels per foot in 1967, offshore exploration has recently been yielding about 250 barrels per foot of exploratory hole drilled.[13]

However, it must be kept in mind that exploration and development offshore are several times more expensive than onshore, and without such success marine petroleum exploration could not continue. This is a good example of the ability of the domestic petroleum industry to meet successfully difficult challenges where the eco-

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[13] *Oil Week,* Feb. 19, 1968, p. 51.

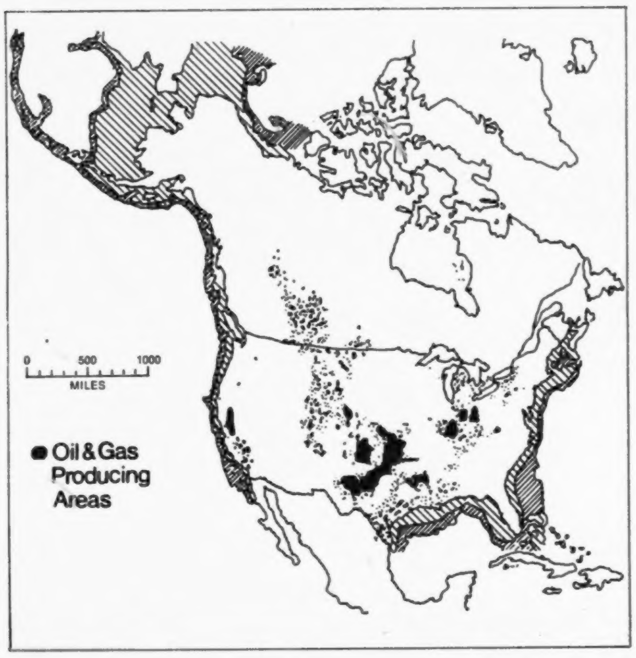

Figure 4. *Map of U.S. continental margins, showing land areas of petroleum production. Source: T.W. Nelson and C.A. Burk, "Petroleum Resources of the Continental Margins of the United States," in* Exploiting the *Ocean (Washington, D.C. 20005: Marine Technology Society, 1966).*

nomic incentives are reasonable and where the governmental administrative framework is not prohibitive.

C. Possible Domestic Substitute Sources of Energy

There are several sources of energy in the United States that have been considered as direct substitutes for petroleum and natural gas, such as the hydrocarbons that can be obtained from oil shale, tar sands, and coal. Other energy sources, such as nuclear and hydroelectric power, can affect the energy consumption patterns, but generally not as direct substitutes for the various uses of oil and gas.

Large reserves of oil shale are known in the United States, especially in the Piceance Basin area of northwestern Colorado and adjacent states. The grade, or organic content, of this shale varies greatly, but a recent report estimates that 80 billion barrels of petroleum is recoverable from shale with an oil-equivalent content of 30 gallons per ton of rock.[14] No shale oil is being produced for a variety of reasons. The Federal government owns approximately 80 per cent of the oil shale reserves and these are encumbered by a series of claims arising under a variety of laws, thus leaving the title in dispute. In addition, while the technologic capabilities are reasonably perfected, the economic factors of this technology under existing circumstances present a formidable barrier to production.

Policies of the Federal government have never been fully developed and until they are there is little likelihood that an oil-shale industry will emerge. Moreover, the very large capital requirements may necessitate the enactment of further economic incentives, such as a higher depletion allowance. It seems likely that shale oil will eventually be economic enough to contribute to the energy demands of the United States, but probably not as a major factor in the energy mix prior to the year 1990. The petroleum industry is presently investing considerable money and effort in studying these problems and in further developing shale-oil technology.

The technology and economics of recovering petroleum from tar sands are in some ways further advanced than those for oil shales. A commercial mining and upgrading project is already underway in western Canada, where it is estimated that about 300 billion barrels may eventually be recoverable. Potential reserves from tar sands in the United States are not large, although there are large quantities of heavy oils that may be amenable to technology similar to that for the tar sands.

Coal can be treated by various processes to yield hydrocarbons in the form of natural gas or petroleum liquids. The overall technology and economics are poorly known and somewhat speculative. It seems likely that the liquefication techniques may yield an economic product earlier than some of the proposed gasification techniques. In certain special cases, one ton of coal could yield three barrels of gasoline and fuel oil. Predicting the extent to which coal treatment may substitute for petroleum or natural gas in domestic energy consumption is as difficult as for shale oil. Even considering the large reserves of coal in the United States, the early production of liquid hydrocarbons and gas from coal would necessarily be in carefully selected and uniquely advantageous deposits, and in even these instances satisfactory technology is not now perfected.

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[14] C. Duncan and V. E. Swanson, *Organic-Rich Shale of the United States and World Land Areas* (Geological Survey Circular, 1965).

Hydroelectric power presently contributes only four per cent of the total domestic energy consumption. Most of the major opportunities for hydroelectric generation have already been utilized; it is difficult to conclude that such an energy source could be expanded much beyond the percentage of domestic energy demand which it now serves.

Nuclear power is predicted by nearly all observers to be a rapidly expanding source of domestic energy, especially for generating plants and particularly if controlled breeder-reactors to utilize U-238 are perfected. Although it will undoubtedly provide a larger share of U.S. energy demands each year, the demand for petroleum and natural gas will continue to increase. The influence of nuclear power on coal consumption may be more significant than for oil or gas.

III. PRESENT OPERATING CAPABILITIES

Offshore oil was actually produced first in about 1894 in California, from wells drilled on wooden wharves or through wells directed seaward from the beach. Petroleum operations in the Gulf of Mexico began in Texas in 1936 and in Louisiana in 1938. However, these were obvious extensions of known resources beneath the shoreline, and in each of these seaward steps one foot was carefully kept on land.

The first geophysical exploration beyond sight of land was conducted in the Gulf of Mexico in October 1944, and the first well drilled beyond sight of land was spudded in August 1946. Unfortunately, this well was dry, but nevertheless these were the first truly major steps into the ocean. The first offshore discovery well was completed off Louisiana in 1947, and the first offshore pipeline was completed in October 1951. The first ocean-bottom well completion was off Peru in September 1960.

Expansion seaward has been rapid since these first small steps. Great improvements have been made in marine geophysical tools and techniques. A whole new generation of vessels has been designed and built to drill in increasingly deeper waters. In the last 10 years, petroleum production has moved from 70 feet of water to more than 300 feet. The first well to be completed entirely under water was installed in Lake Erie in 1959, and now there are probably more than 50 such completions in waters that exceed 250 feet deep.

The first field to be produced from a man-made island was in California in 1953-1956, and several other islands have now been added to this coast. Pipelines have now successfully been laid in more than 300 feet of water, and production has been established at least 70 miles from shore.

In the last 10 years, the maximum water depth in which production wells could be drilled has progressed from about 100 feet to more than 600 feet. These depths include most of the world's continental shelves; however, exploration has not stopped there. Leases have been granted by the Department of the Interior for petroleum exploration and production more than 100 miles off the U.S. shores, and in waters up to 1,800 feet deep. About 100 core holes have already been drilled beyond the U.S. continental shelves, some in waters nearly 5,000 feet deep.

The search for petroleum beneath the oceans is not only pushing steadily toward deeper waters, but it is already a firmly established international effort. Production has been established off nearly 22 nations and exploration is underway off the shores of more than 75 countries on five continents. Drilling rigs are now at work on the continental shelves of 35 countries and 15 more are expected soon.

This expansion over the last two decades has indeed been spectacular, but it has required a great deal of engineering and scientific ingenuity as well as vast amounts of risk capital.

Even though this growth has been rapid it has been an evolutionary (rather than a revolutionary) expansion, where each new step was soundly based on the experience and knowledge gained from the preceding steps. This pattern can be expected to continue as production capabilities step into the deeper and more remote waters of the world.

A. Exploration Capabilities

Geophysical exploration is probably the only aspect of marine petroleum development which is faster and cheaper offshore than it is on land. This is due to the fact that there are fewer barriers at sea to rapid and direct transportation, and that geophysical techniques have been developed which allow a ship to collect data while underway; hence, the cost per mile of survey is less than on land.

However, it is still not inexpensive; detailed studies can cost more than $500 per mile, and even regional studies may cost more than $100 per mile. In addition, much more geophysical work must be done at sea than on land since this is the only way, short of drilling, that either the broad geological framework or specific details of the geology can be determined in the oceans.

Techniques are continually being developed to increase the speed of a survey and the reliability of the data collected, and to decrease the costs. The earlier surveys were carried out using dynamite as the seismic energy source, but such data are now largely collected using a great variety of non-explosive energy sources (electrical sparks, air guns, contained gas explosions, vibrating plates, and others). Seismic data also are now routinely recorded on magnetic tape and treated by digital computers to enhance the quality and reliability of the data.

Marine magnetometers are very convenient and allow accurate measurement of the earth's magnetic field while underway. Marine gravimeters are now being used which can determine very small variations in the earth's gravity field while underway at sea, even with very large movements of the ship.

Such geophysical work can be carried out in any depth of water and at any distance from land.

These geophysical techniques are indirect methods for examining the rocks which comprise our continental margins, and it is obviously much more difficult and expensive to obtain samples of these rocks at sea than on land. The most satisfactory method to date has been with the small coring ship which drills a hole a few hundred feet into the sea floor and recovers samples of the rock for further study (Figure 5). Approximately 100 such holes have already been cored in the U.S. continental margin beyond the shelves, penetrating up to 1,000 feet beneath the sea floor in waters from 600 feet to nearly 5,000 feet deep. As long ago as 1961, the petroleum industry drilled several experimental core holes in 12,000 feet of water as part of the early phase of Project Mohole.

A group of oceanographic institutions (Joint Oceanographic Institutions Deep Earth Sampling) has obtained a Federal grant to contract the drilling of a series of core holes to sample up to 2,500 feet below the sea floor in water depths as

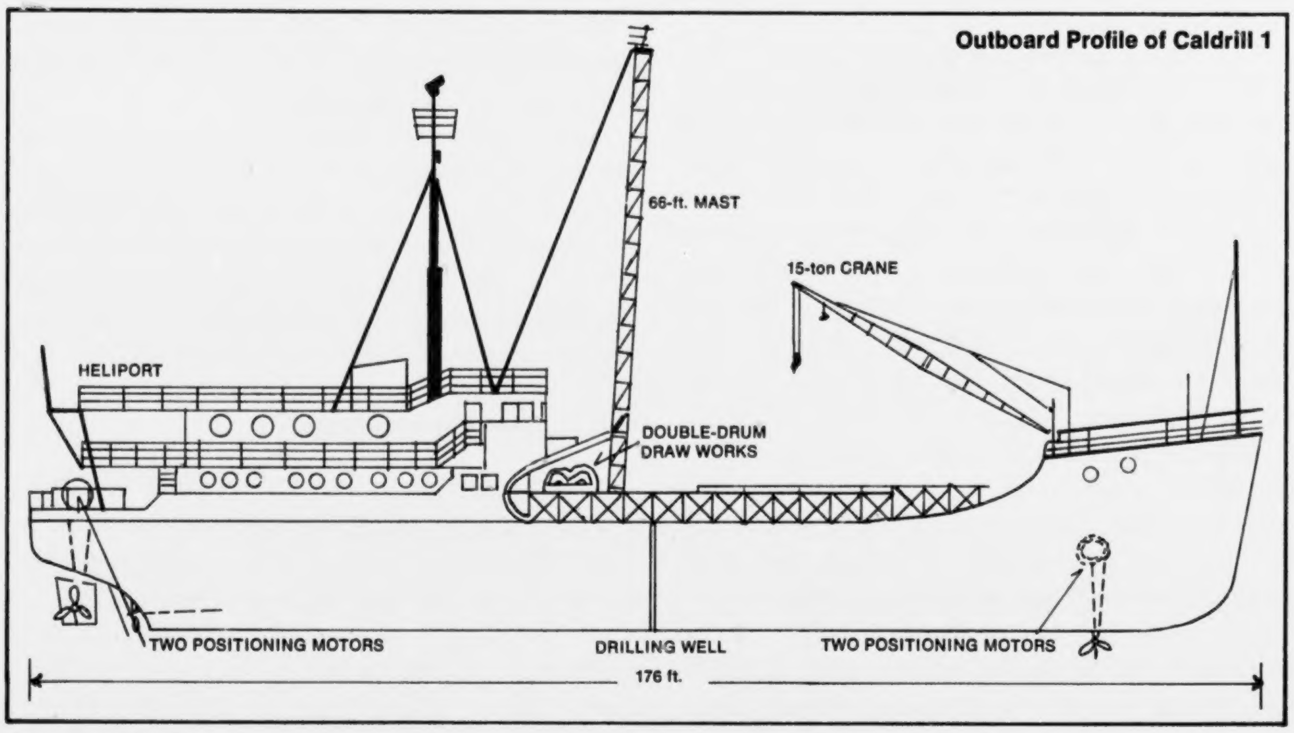

Figure 5. *Marine coring vessel*

great as 20,000 feet. This program of basic scientific investigation, utilizing the equipment and capabilities of the petroleum industry, will explore in several of the world's oceans and major seas.

In general, there are no operating limitations to geological and geophysical evaluation of the U.S. continental margins. However, the only way that the presence or absence of oil or gas can ever be determined is by drilling of exploratory wells deep into the rocks beneath the sea floor.

B. Drilling Capabilities

The drilling of an exploration or development well is more difficult and expensive than drilling a core hole because repeated reentry into the hole is required, casing must be set in the hole to keep it open and control drilling fluids or fluids in the rock, large blowout preventors must be installed in case high-pressure oil or gas is encountered, and the drilling rig must maintain position at the wellsite for many weeks or months instead of a few days. More than 9,000 wells have already been drilled into the U.S. continental shelves. The deepest water, 632 feet, in which an exploration well has been successfully drilled is located off southern California. Similar wells have been drilled in the Mediterranean off Libya. This depth includes virtually all of the U.S. continental shelves.

The petroleum industry has more than $1 billion worth of offshore drilling equipment presently at work. Nearly 150 mobile drilling vessels are now operating, some costing more than $10 million to build and up to $750,000 a month to operate. Some have the drilling rig mounted on a conventional ship-shaped hull; others have legs taller than a 30-story building which are jacked down to the sea floor in order to raise the drilling platform above the turbulent surface of the sea; others are floated to the drilling site on similar tall legs, which are then flooded to rest on the sea floor; and in others the drilling platform is held above the sea surface by partly submerged buoyant legs (Figure 6).

The floating drilling vessels are normally secured over the drill hole by a system of anchors. However, many of the newer vessels for deep water are equipped with various types of propellers that can dynamically position the vessel over the hole during drilling. There is little doubt that exploratory and production wells can now be drilled successfully in water as deep as 1,000 feet. One company recently announced that they plan to drill a well off California in 1,300 feet of water by the end of 1968.

C. Production Capabilities

The ability to explore and to drill for marine petroleum resources in deep water presently exceeds the capability to produce it once it is found. This may be due in part to the fact that exploration has only very recently been extended into deep-water areas, and there is as yet no need for deep-water production capabilities. However, it is also true that many of the problems associated with petroleum production at sea are more difficult to solve than those associated with marine exploration or drilling.

A completed well must be accessible for periodic maintenance. Oil wells may require paraffin and sand removal, corrosion prevention, and both oil and gas wells may require remedial work on the hole itself. Separation and treating equipment is needed to provide adequate separation and measurement of the oil, gas, water, and natural gas liquids produced. Oil and natural gas liquids also must normally be stored and measured before transportation to the shore or to an offshore loading facility. The producing well must have flexible control mechanisms for well-testing, flow-rate control and shutdown during emergencies. Gas is normally flowed directly into the pipeline, but commonly a major problem is the formation of solid hydrates which plug lines and valves under certain temperature and pressure conditions.

These and other problems have been solved to date largely by installing the well-head and producing equipment on permanent platforms resting on the sea floor and standing above sea level. In other cases the subsurface reservoir is close enough to shore that the well-head and producing equipment can be located on land, and in other cases man-made islands have been built to hold these facilities. Obviously these approaches are confined to fairly shallow waters. Permanent platforms, however, have now been installed in 340 feet of water off Louisiana and some companies believe they can be installed in 600 feet of water or more. Under some conditions as many as 60 wells can be drilled directionally from a single production

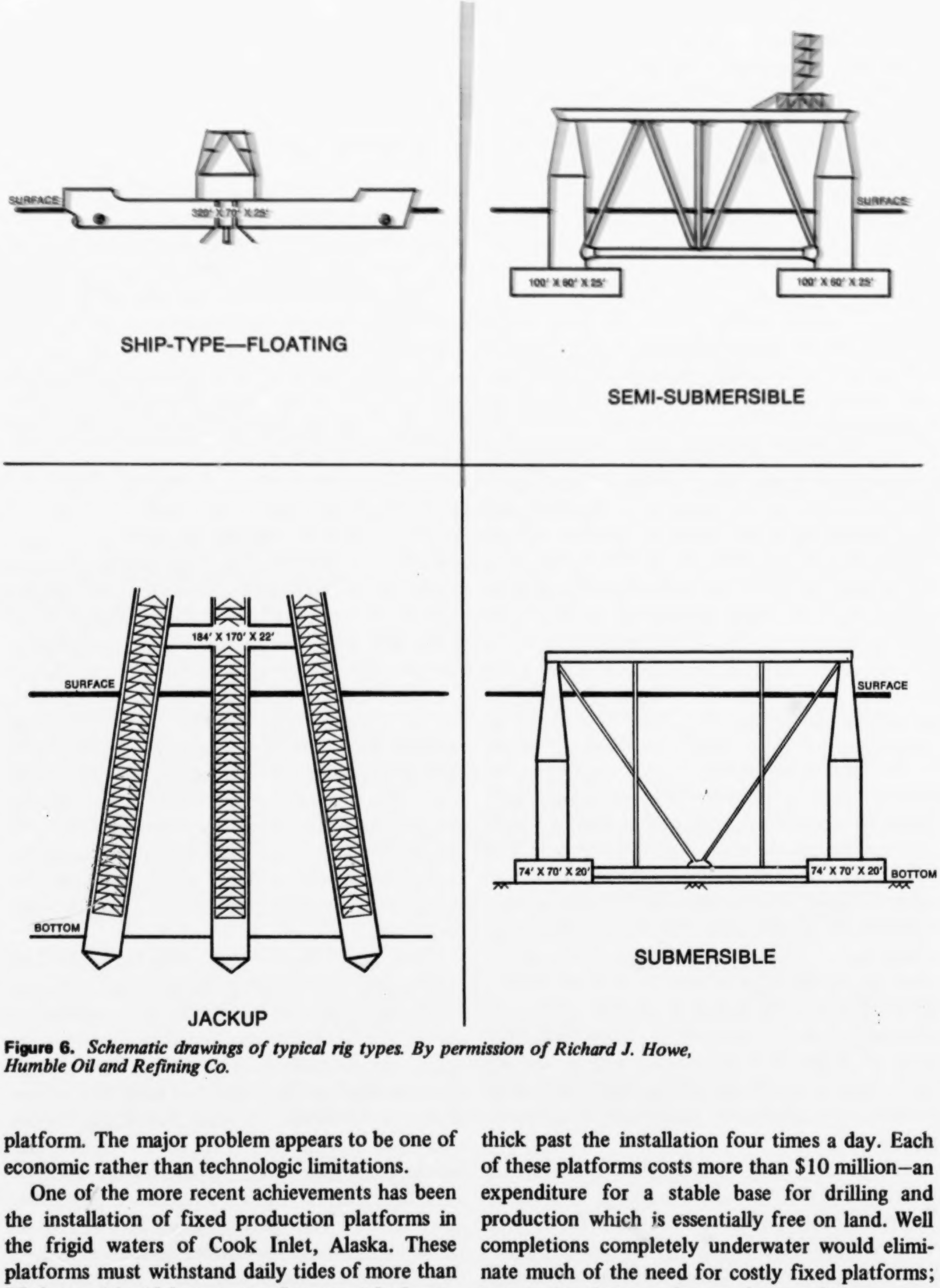
SURFACE
320' X 70' X 25'
SHIP-TYPE—FLOATING
SURFACE
100' X 60' X 25'
100' X 60' X 25'
SEMI-SUBMERSIBLE
184' X 170' X 22'
SURFACE
BOTTOM
JACKUP
SURFACE
74' X 70' X 20'
74' X 70' X 20'
BOTTOM
SUBMERSIBLE

Figure 6. *Schematic drawings of typical rig types. By permission of Richard J. Howe, Humble Oil and Refining Co.*

platform. The major problem appears to be one of economic rather than technologic limitations.

One of the more recent achievements has been the installation of fixed production platforms in the frigid waters of Cook Inlet, Alaska. These platforms must withstand daily tides of more than 25 feet, with tidal currents of up to eight knots, which in the winter move pack ice up to six feet thick past the installation four times a day. Each of these platforms costs more than $10 million—an expenditure for a stable base for drilling and production which is essentially free on land. Well completions completely underwater would eliminate much of the need for costly fixed platforms; but it is obvious that such completions pose significant problems in meeting requirements, and that they might not be appreciably less expensive. However, there are already about 50 such underwater completions in water up to 250 feet deep throughout the world. Various techniques are being developed by many companies to extend these capabilities to much deeper waters.

Generally, the capability now exists to complete wells in about 350 feet of water and it is likely that in the near future production may be flowing from depths exceeding 600 feet in certain specialized locations nearshore or near fixed platforms. Extension of producing capabilities to even deeper waters may be more a problem in economics than one of technologic capability, although there are still some difficult technologic problems to solve.

D. Transportation Capabilities

Pipelines must be laid in any offshore field to gather the production from individual wells into a central collecting point where it is separated, measured and put into a larger pipeline to shore or where it is stored prior to being loaded onto a barge or tanker for transportation to a refinery. Such major pipelines have been laid in the Gulf of Mexico in lengths exceeding 100 miles in shallow water. An 88-mile, 22-inch line has been laid in more than 300 feet of water in the Persian Gulf. Gathering lines within a field have been laid in 340 feet of water in the Gulf of Mexico. These may be buried or laid directly on the sea floor.

A French firm demonstrated in 1966 that underwater pipelines can be laid at considerable water depths. This experimental, small-gauge, special-purpose line was laid in the Cassidaigne Deep, near Marseille, in water as deep as 1,080 feet.[15] As with deep-water completions, the major limitation in marine pipelines is certainly one of economics and also of improved technological capability. Pipelines for natural gas must be of much larger diameter than those necessary for petroleum, and the cost may locally be from five to ten times the cost of the same line on shore. Oil pipelines commonly cost five times as much as their equivalents on land. Long-distance pipelines require the same facilities as onshore lines, including pump stations, valves, and manifolds. These add further to the cost of long-distance or deep-water marine pipelines.

Another factor which will limit the laying of marine pipelines is the successful development of offshore storage as well as efficient and low-cost tankers and barges. Oil can be shipped completely around the Arabian Peninsula from the Persian Gulf to the Mediterranean for approximately the same cost as it is moved less than a third that distance by pipeline (even on land) across the head of the Arabian Peninsula.

Production pipelines have been laid in waters greater than 300 feet deep and in lengths exceeding 100 miles. Smaller diameter gathering lines have been laid experimentally in far greater water depths. As difficult as it is, technology is probably less of a limiting factor with marine pipelines than are the economics of such lines. However, where pipelines become impractical, new methods of offshore storage and transportation may solve the problem. Several methods for loading tankers at sea have been developed and others are being designed.

Natural gas presents more of a problem since the larger-diameter pipelines required are even more expensive and present more difficult technological problems. Cryogenic liquefaction of natural gas is only practical for transportation great distances or perhaps where pipeline technology is very difficult. Liquefaction requires major shore-based installations, but such programs are already planned or underway between Algeria and France and England, and between Alaska and Borneo and Japan.

IV. ECONOMICS OF MARINE OIL AND GAS DEVELOPMENT

Petroleum exploration and production is at best a risky and expensive enterprise. It requires vast amounts of money, technical know-how and experience; nowhere is this more true than in the inhospitable and largely unknown environment of the oceans. Except for geophysical surveys, there is no aspect of marine petroleum development that is not at least several times as expensive as on land. Vast amounts of risk and investment capital will continue to be required as marine petroleum development continues to expand into deeper and more remote waters. However, the petroleum industry has been willing to make these large investments and develop the necessary technology because it has been operating in a framework of reasonable profit incentives; industry has succeeded in producing these marine resources economically and in competition with other available domestic sources. There appears to be little doubt that the industry will continue to expand these efforts into ever-deeper waters throughout the world so long as it can be done economically.

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[15] Les Conduites Immergees, *The Las Cassidaigne Sea Line, Special Report* (1967); *cf. Oil and Gas Journal,* July 10, 1968, pp. 125-126.

A. Physical Limitations

As discussed above, there are probably no purely technological limitations to developing the petroleum resources throughout all of the continental shelves of the United States, and possibly into much deeper water as well. The principal limitations are the economics of the technology and the oil or gas field.

Among the physical factors affecting the economics are the size, shape, and depth of an oil or gas reservoir, its physical characteristics (porosity, permeability, and reservoir pressures), the depth of water overlying the reservoir, and its distance from shore. The ice-bound waters over much of Alaska's continental shelves present a specific problem in both technology and economics.

If a large enough field could be found offshore, with thick reservoir beds and high productive capacity of several billion barrels of reserves, it is possible that it could be developed economically in very great water depths with technology that exists now or which could be employed in a short time; the cost of development becomes less important as the volume of the reserves and the production rate increase. However, it is unlikely that a reservoir of this size will be found on U.S. continental margins. Conversely, technology and efficiency become extremely important in smaller fields—say less than 100 million barrels of reserves which are typical of those now being developed offshore.

Similarly, if an oil field covers a large area, requiring the drilling of a great many wells, it is less economic than a field containing the same volume of reserves but confined to a small geographic area. It is also much more expensive to develop a field which is 20,000 feet below the earth's surface than a field of the same size which is 10,000 feet deep. The economic feasibility of developing a field is also limited if the petroleum can be produced only along with formation water or unmarketable natural gas.

There are a few purely physical or technological barriers to developing marine petroleum deposits; these are completely interdependent with the economic limitations. J. E. Wilson,[16] of Shell Oil Company, recently commented on this relationship between technology and economics:

> *I say without rancor that it seems everybody wants to help the oil industry solve the problems of offshore operations . . . We aren't the least bit reticent about using ideas and help wherever they may be found. The main drawback is that it all costs money. For instance, I think we could today get the equipment built to drill and operate an oil field completely beneath the sea—and would, if that were the cheapest way.*

The petroleum industry is continuing to make great improvements in technological capabilities and efficiency, and as long as fields of reasonable size can be found there is every reason to expect continued development of U.S. marine petroleum resources. In fact, much of the investment offshore to date has been made on the assumption by industry that development technology could be improved sufficiently to extend the economic limits now imposed by water depth, distance from shore, field size, and field depth.

B. Economic Limitations

Most of the world's marine wells have been drilled in the waters off Louisiana. An historical review of petroleum development in this area should be the most adequate economic evaluation available. Such a review has recently been made by T. D. Barrow,[17] considering the 15-year history between 1951 and 1965. The geophysical work by industry devoted to finding new fields during this period which amounted to about $160 million, and approximately $1 billion was actually spent in competitive bidding to acquire exploratory leases.

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[16] J. E. Wilson, *Economics of Offshore Louisiana* (Annual Meeting of Louisiana-Arkansas Division, Mid-Continent Oil and Gas Association, preprint, Sept. 12, 1967).

[17] T. D. Barrow, Economics of Offshore Development, in *Exploration and Economics of the Petroleum Industry* (Houston: Gulf Publishing Co., 1967), pp. 133-147.

The total cost of wildcat drilling during this period was about $280 million. The largest number of exploratory holes drilled (144) was in the year immediately following the largest lease sale (Figure 7); such extreme surges of drilling activity add to the cost of offshore exploration through the resulting inefficiencies in scheduling giant mobile rigs, as well as the supporting equipment, facilities and personnel. The total exploration expenditure during this 15-year period was thus about $1.6 billion, the largest part of which (65 per cent) was lease purchases. The total past and projected development costs are $4.7 billion, giving a total investment of $6.3 billion.

Barrow estimated that ultimate production from fields discovered between 1951 and 1965 would amount to 3.6 billion barrels of oil and 49 trillion cubic feet of natural gas. The eventual actual profit that can be expected after return of investment and payment of taxes will thus be $5.6 billion, for a profit to investment ratio of 0.9. However, Barrow notes that since some of the initial investments were made as early as 1944 and some of the eventual income will not be received until the year 2000, "the Investor's Interest Rate, or the discounted cash flow rate of return for this industry investment will be only seven per cent." An important further point is that a long development period is required after a successful discovery before production can reach any significant volume.

These figures are for the industry as a whole, but Barrow emphasizes that the results for individual companies vary greatly (Figure 8). The company which spent the most money in acquiring competitive leases had production in mid-1966 on those leases of 66,000 equivalent barrels of oil per day, but the second largest lease purchaser had obtained only negligible production. One company had spent about $50 million on bonuses during this period and had found no production. This clearly indicates the large economic risks involved in this type of exploration. Barrow further pointed out that for each million acres nominated in a

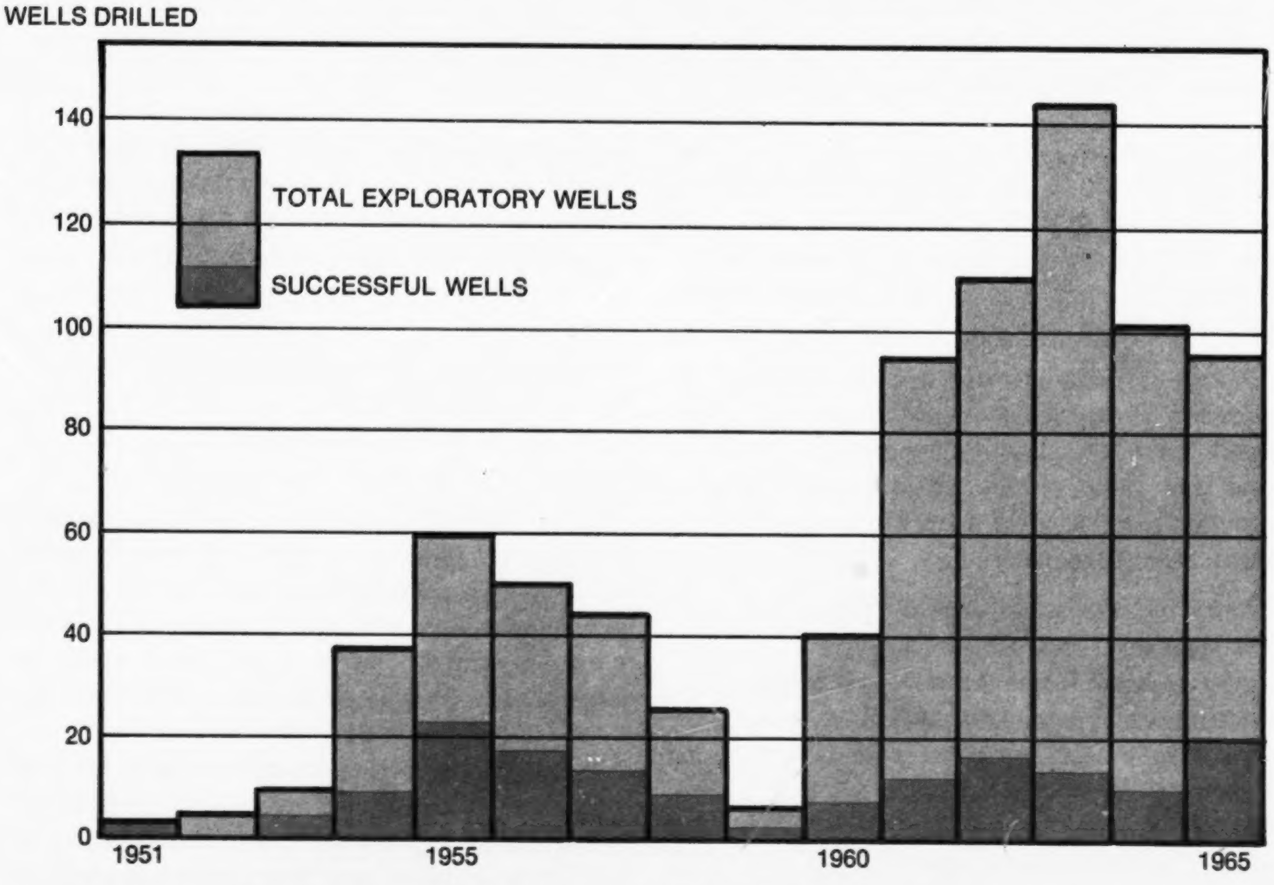

Figure 7. *Industry wildcat drilling activity 1951 through 1965 offshore Louisiana. Source: T.D. Barrow, "Economics of Offshore Development," in* Exploration and Economics of the Petroleum Industry *(Houston: Gulf Publishing Co., 1967).*

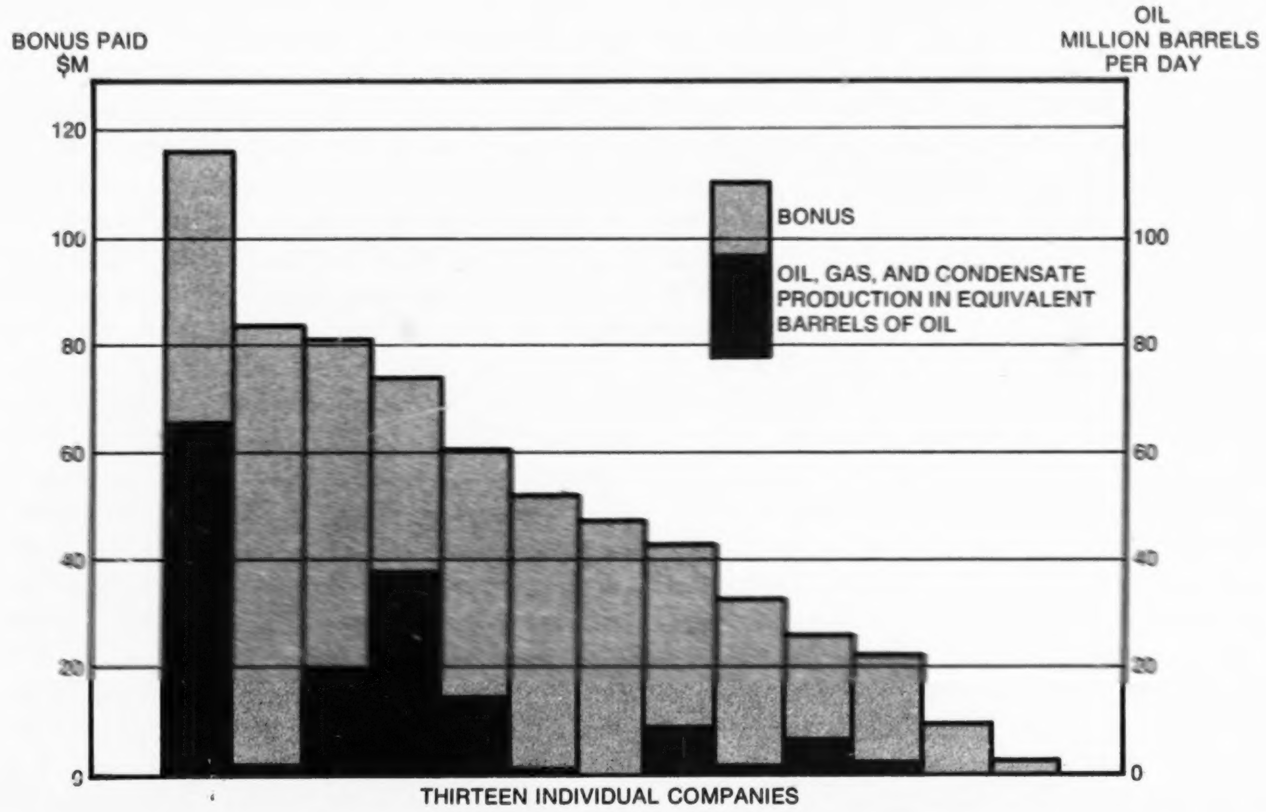

Figure 8. *Bonus spent 1954, 1955, 1960, and 1962 sales and mid-1966 production from purchased leases thirteen operators–offshore Louisiana. Source: T.D. Barrow, "Economics of Offshore Development," in* Exploration and Economics of the Petroleum Industry *(Houston: Gulf Publishing Co., 1967).*

wildcat lease sale, historically it has taken the industry over three years to achieve only 10,000 barrels per day of production from the successful leases. About 90 per cent of all oil and gas produced from offshore Louisiana in 1965 came from fields discovered prior to 1957.

There is little doubt that development of petroleum resources in deeper waters and more remote areas will require improved technology, larger and more prolific fields, more attractive economics, or all three in order to justify continued large expenditures.

Many of the technological advances to date have been developed under cooperative and cost-sharing research plans between oil companies—environmental prediction, welding techniques, foundation design, underwater equipment, joint geophysical surveys, metal corrosion and fatigue. Most of the engineering data required by the industry is obtained in-house.

Such cooperative efforts appear to be of great value and could be encouraged, without amending the antitrust laws, in order to minimize redundant expenditures where they involve basically non-competitive aspects. Moreover, proprietary information thus obtained is often made available to non-participants subject to a reasonable licensing system. Similarly, the smaller producing companies have been able in several instances to compete with the larger companies in the high economic framework offshore by joining together in small groups and jointly sharing the risks and capital requirements.

Present insurance rates for offshore operations and drilling rigs are extremely high, and increasing regularly. It is doubtful that the U.S. and London insurance markets will have the capacity to underwrite this kind of risk at a cost which would be commercially feasible. It has been suggested that the petroleum industry consider organizing so-called reciprocal insurers or self-insurance pools to reduce these costs. Such reciprocal insurers are authorized by existing state insurance laws and do not violate antitrust laws if boycotts and coercion practices are avoided. Such insurance arrangements could in the future reduce this major expense in offshore operations.

C. Competitiveness of Domestic Offshore Oil and Gas

Offshore oil and gas compete for the same domestic markets as onshore production. Market demand for petroleum is a fairly stable quantity (except, of course, in times of national or international emergencies). Total refinery and petrochemical supplies from domestic sources are reduced by the quantity of imported supply allowable under the Federal Mandatory Oil Import Program.

In areas where producing capabilities exceed demand, production is prorated among the wells according to various state regulatory authorities. The west coast is deficient in petroleum resources compared to demand; hence there is no prorationing of production in California. However, there is a surplus of producing capability in the south-central United States. Louisiana, and particularly Texas, thus act to provide an overall balancing mechanism between total demand and total domestic supply. Such proration also serves the important function of conserving these resources in the most practical way, by conserving the reservoir energy, so that the ultimate production will be as high as possible.

Offshore oil production (practically all off Louisiana at the present time) from the Outer Continental Shelf (OCS or Federally controlled offshore areas) is made a part of the State allowable framework by tacit consent of the Federal Government. Offshore allowables are set higher than onshore by a varying "equity ratio" in recognition of the higher costs of marine operations. However, offshore petroleum prices are directly comparable to onshore prices and must compete with them on the market. The Federal royalty offshore is normally 16-2/3 per cent, where onshore it is usually 12-1/2 per cent.

Offshore gas production is similarly competing for the same markets as onshore gas. The largest proportion of gas production, whether from onshore or offshore sources, is sold at the well-head or at processing plants to gas transmission companies on the basis of long-term purchase contracts which specify price and rate of withdrawal. Where this gas production originates in Federal leases or where it moves through interstate pipelines the price is controlled directly by judgments of the Federal Power Commission.

If offshore producing capabilities were to rise considerably faster than the growth in national demand, this could of course produce some effects on production onshore in those areas of proration. However, with a tightly controlled import policy and a rapidly expanding domestic demand any such dislocation would probably be minor in the long run.

It is estimated that by 1978 domestic crude production will be about 10 million barrels per day and that by 1988 it will be less than 9 million. These estimates allow a two-fold increase in per cent demand supplied by foreign imports by 1988 (an actual increase of 2.7 to nearly 9 million barrels per day), and a supply of synthetic hydrocarbons of greater than five per cent. Conventional domestic production may supply only half of our needs by that date. It is likely that by the mid-1980's Texas and Louisiana will be producing at the maximum efficient rate (mer), and it is questionable whether market proration will still be in effect.

Inevitably there will be increasing utilization of existing producing capacity so that any major new sources of production, such as offshore, should be able to be absorbed into the existing administrative framework without undue difficulties. Given the high cost and inherent time delay in developing marine production it seems doubtful that industry would be able to accelerate offshore development to a point where it would have a significant or lasting impact on onshore production. The discovery of a new field offshore has no more of an impact on allowables than does a new discovery onshore, except for the offshore equity allowable, which is only a small recognition of the much greater investment cost required offshore.

In summary, the petroleum industry so far has successfully been able to discover, develop and produce domestic marine petroleum resources economically and in direct competition with other available sources onshore.

Domestic petroleum is not competitive on the international market, largely because of the large volumes and low cost of oil reserves in the Middle East and the high cost of domestic reserves. However, the historic policy of the United States is that we cannot afford to become excessively dependent on foreign oil imports and must maintain an excess producing capability to meet national security requirements in case of national or international emergencies.

Availability of an adequate domestic supply has proved to be of critical importance several times in the past: during two world wars and during the Arab-Israeli confrontations in 1957 and 1967. To maintain its indigenous reserve, the United States is paying a premium over imported crude in excess of a dollar a barrel for its oil supplies. Canada, our nearest neighbor, has taken a similar approach but pays a somewhat smaller premium.

D. National Security, Import Quotas, and Prorationing

Minerals underlying the earth's surface are in the public domain under the law in most countries and do not belong to the surface owners. Under Anglo-American law, however, mineral rights generally go with surface ownership. While this creates no difficulty with solid minerals, in the case of oil the direct link between surface ownership and the mineral resource is broken; a well drilled into an oil reservoir from one piece of property may drain oil from under other ownership tracts which also overlie that reservoir.

Moreover, at high rates of production and without compensation measures, there is generally an inverse relationship between the rate of flow from a pool and the total amount of oil that can be recovered by primary means, for a variety of complicated reasons.

Experience in the United States and other countries has demonstrated beyond any doubt that completely unrestricted crude oil production has led to serious physical and economic waste. It is essential in the case of public resources that the "external" costs inflicted on one oil property lessor by another in the process of draining oil from a common pool be corrected in order to achieve a production program that maximizes the net economic value available from the petroleum resource.

In general, State regulatory practices are now designed to overcome the adverse effects of the common property status of oil lying in pools beneath lands subject to multiple ownership where there is a corresponding rush to produce oil before a neighbor drains the pool. Techniques have been devised to coordinate the production of all States having excess producing capacity with current market demand, and to prorate each State total into production quotas for individual producers. In the aggregate, the prorationing measures of the individual states operate to prevent excessive levels of crude production in the Nation and to dampen price fluctuations, as well as to minimize the detrimental reservoir effects of excessive rates of production. Reservoir conservation is also encouraged on Federal leases by control of gas-flaring, by encouraging unitization of reservoirs and fields, and by other means.

The effectiveness of State control is increased tremendously by Federal legislation prohibiting interstate shipment of oil produced in excess of State quotas. The prorationing program is further implemented by Federal action limiting crude oil imports. The Federal Government also effects total production less directly through its leasing policies for Federally owned land, both onshore and offshore. Although offshore production from leased lands lying outside State jurisdiction is not formally included in the State prorationing mechanism, the Federal Government has chosen to include such production within State prorationing in the only two States, Texas and Louisiana, where it is of current significance.

The objectives of Federal oil policy are complex, and they involve issues of major National significance. Oil is a strategic material of prime importance, affecting both the military capacity of the Nation and its economic well-being and rate of growth. There are, of course, substitutes for petroleum in virtually all uses, but for some—particularly transportation—petroleum products have advantages so great as to make them nearly indispensable to a modern industrial economy. Clearly, therefore, the Federal Government must be concerned with the state of the Nation's petroleum reserve; its access to new supplies; incentives for exploration and development by industry; and flexibility and resiliency of the industry in the face of possible adverse developments that could cut off, partially or entirely, imports of both crude and refined products.

Formulation of the relations between the various segments of the petroleum industry, State and Federal Governments, that bear on national security raises a series of extraordinarily complicated issues. The combination of policies outlined above has, by its very nature, held U.S. crude petroleum prices well above world market level: in recent years, by as much as $1 per barrel. These policies have been defended not only in terms of conservation and capacity to meet emergencies, but also as incentives for intensified domestic exploration and development activity. In a short run sense, these arguments are generally valid. From a longer term viewpoint, however, these policies may have adverse effects on overall National security. They promote not only rapid exploration but also rapid exploitation of domestic supplies, thus reducing American reserves that may be found, perhaps hastening the day when our present marginal dependence on imported sources or substitute fuels will become a major one.

It has become abundantly clear in recent years that even the incentives provided in the form of depletion allowances and other tax considerations have not been sufficient to keep new discoveries at a level sufficient to offset rising domestic demand. There is, therefore, a real issue as to whether it is in the National interest to encourage exploitation as well as exploration from domestic sources, if the effect is a continuous reduction in the reserves under the political and physical control of this country.

From a long term standpoint, the Nation's military and economic security may be better served by drawing upon other people's petroleum reserves to a larger extent (which would also permit a considerable reduction in the average cost of petroleum products to American industry and consumers) while preserving more of our own onshore and offshore resources against years of future need. The Commission has not been able to determine whether such alternatives have been fully evaluated in the formulation of a National defense policy for petroleum.

It is quite possible that the most efficient way of providing a protected reserve of crude petroleum sufficient to meet any possible contingency may be to provide incentive for exploration and proving up of reserves without a corresponding stimulus to early production if such a system can be devised. As the incentive program now operates, it provides rewards for expanded exploration but also generates strong financial pressure for production at the earliest possible date. Such a policy may tend to defeat the security reserve concept.

Since offshore oil is, for practical purposes, fully integrated with onshore supplies, any appraisal of National security requirements with respect to petroleum must influence Federal leasing policy and hence the rate of development of petroleum resources on the continental margins. Under present arrangements, offshore oil from Federal lands is subject to prorationing off Texas and Louisiana. Texas and Louisiana afford offshore operations somewhat more generous "allowables" (i.e., they are permitted production in excess of that allowed for a similar onshore well) as an incentive for deeper exploration and drilling and to compensate to some extent for the added cost of offshore development.

Carried to its logical conclusion, it is apparent that if offshore production beyond State boundaries were not subject to prorationing, the rate of development of these supplies would be increased in some degree. To the extent that there is a National interest in expanding the pace of offshore oil production, the policy of allowing unrestricted production from offshore Federal lands would be a significant positive step. Moreover, the larger lease size and the limited number of lease holders in offshore Federal areas tend to assure that adjacent leases will be developed on a unitized basis without the destructive and wasteful race to produce from a common pool that has made prorationing necessary in Texas, Louisiana, and other States.

The effect on the present structure and operation of the domestic petroleum industry of unrestricted production from offshore Federal leases is not certain, but it would not appear to be of major proportions. At present, offshore production from Federal lands accounts for only about eight per cent of total United States production. While this production is expected to increase in the future, the increase in domestic demand is certain to outstrip the growth in production from all domestic sources. Thus, the industry anticipates that restriction on individual well production under the present prorationing program will be reduced steadily and should virtually disappear by the early 1980's. If offshore oil is allowed to enter the market without prorationing, it would create a short run adjustment period of varying degrees of difficulty for onshore producers, but the problem will eventually disappear with growth.

The panel takes no specific position on these complex issues. The panel simply notes that the problems of adjusting oil production from domestic sources, both onshore and offshore, to some level that is optimal from the standpoint of National security, economic growth, and the well being of the country and the petroleum industry have not been fully answered to date. In addition, there may well be some conflict among these desirable objectives. Since the offshore oil potential on Federally owned lands constitutes a major proportion of the remaining reserves under direct control of the United States, it is essential that these interrelated objectives and the complex decisions required to adjust industry-government policies to achieve them be analyzed in far greater detail than this Commission was able to undertake. In particular, the Nation needs to know the alternative means of assuring that National security requirements can be met with respect to petroleum and the costs to the economy of achieving that security under each alternative.

It is mandatory that the security issue be defined in specific terms and that the Nation adopt policies to assure that it be resolved at the lowest cost and with a minimal detrimental effect on the normal business activities of the petroleum industry.

V. LEGAL AND ADMINISTRATIVE FRAMEWORK

Offshore petroleum development is administered, with few exceptions, exactly as it is on land and largely by the same governmental agencies. The principal differences are that all exploration and production is on Federal or State leases (there are no private mineral rights offshore) and oil and gas leases can be acquired only by competitive bidding. Offshore petroleum production has now been established on Federal and State leases off California, Louisiana, and Texas, and in State waters off Alaska.

An important problem in the orderly development of marine petroleum resources in the past has been the controversy between Federal and State governments concerning royalties, bonuses, and jurisdiction of these areas. The first suit between these governments was filed in 1945 and others followed in 1948. A start was made in resolving these disputes by passage of the Submerged Lands Act in 1953. The major dispute in California waters was resolved only recently by a Supreme Court decision and the problem in the Gulf of Mexico has only partly been solved. In the second *Louisiana* case, the Supreme Court held that Louisiana, Mississippi, and Alabama were entitled to boundaries three miles from their coasts, with islands to be treated separately. The issue to determine the base line along the coast of Louisiana is now before the Supreme Court.

A. State Regulation

The only production to date on the West Coast of the United States is in California and Alaska. However, exploration is presently underway and leases have been issued off Oregon and Washington as well. In California, the State Lands Commission is responsible for administration of all state lands, but the State Lands Division of the Department of Finance acts as the operating and administrative agency for the State Lands Commission. Permits are required to conduct any geophysical surveys using explosives and for all core drilling operations. The California Department of Natural Resources, through the Division of Oil and Gas, supervises drilling, producing, and abandoning operations to prevent waste or damage; collects statistical records and reports; conducts field inspections of blowout prevention equipment, cementing and plugging operations, and water shut-off operations. The State Game and Fish Commission also issues permits for geophysical surveys which require explosives and an inspector must be present during all operations. The State has industrial safety inspectors who must approve all oil or gas operations, and regulations and policing of all possible sources of pollution are State-controlled.

In Alaska, the State Department of Natural Resources, through the Division of Lands and the Division of Mines and Minerals, handles all oil and gas matters. Leases are awarded by sealed bonus bids. As an incentive to exploration, Alaska has allowed a reduction in state royalty from the usual 12-1/2 per cent to 5 per cent for the first 10 years of production for any lease on which a new-field discovery is made. In view of the large reserves now established in the upper Cook Inlet, the discovery royalty no longer applies in this area.

The State supervises and regulates all drilling and producing operations. Recent leases also require that the State Game and Fish Commission be notified in advance of any proposed geophysical work and of any proposed drilling sites.

The Oil and Gas Conservation Committee of the State of Washington supervises all drilling and producing operations and issues all rules and regulations considered to be necessary. An inspector is required to be present for all coring and sampling operations. The State Department of Fisheries controls all geophysical exploration which involves explosives and an observer is on board at all times. Similar functions in Oregon are governed by the Department of Geology and Mineral Industries. The Oregon State Land Board conducts lease sales and the Fish and Game Commission is consulted by the Board on all geophysical and geological permits.

The governing structure and the specific rules and regulations are generally similar between all of the States on the Atlantic seaboard and the west coast States. Each State adjusts the necessary regulation to fit its particular administrative structure; from two to nearly a dozen State agencies may become involved in administering these regulations. This of course imposes something of an administrative burden on the operating companies since they must in turn respond to this complex governing structure.

The existing legal environment in the Gulf of Mexico is more confusing and cumbersome to private industry than it is restrictive. The conflict between Federal and State governments over jurisdiction, bonuses, and royalty has been a problem since offshore oil was first discovered off Louisiana more than two decades ago. The Submerged Lands Act and the Outer Continental Shelf Lands Act of 1953 helped alleviate this problem; an interim operating agreement in 1956 between the Department of the Interior and the State of Louisiana provided areas in which oil operations would be allowed without interference, defining two zones as "disputed areas" and expressly reserving the claims of the United States and Louisiana to two other zones. The zone still disputed lies between about three and nine nautical miles from the coast. In this area industry must meet both Federal and State regulations and try to satisfy all of the many agencies involved. Recent boundary alterations have changed the configuration of this disputed zone as a result of a Supreme Court Supplemental Decree in 1965. The final resolution of jurisdictional boundaries will depend on Supreme Court determination of the base line along the coast from which to measure these jurisdictional limits.

Recommendation:

The continuing efforts to solve Federal-State offshore jurisdictional problems by negotiation or court settlement should be accelerated.

Louisiana's Department of Conservation regulates offshore petroleum operations in both the disputed and undisputed areas, but all revenue from the disputed zone is being held in escrow until the dispute is resolved. The district manager of the Department of Conservation evaluates all drilling operations, completions, and other functions normal to oil field operations. The Department has inspection teams which move unannounced into offshore fields to check well tests, inspect for pollution, and evaluate safety measures. The Louisiana Mineral Board controls all leasing of State lands, and also makes recommendations for unitization (requiring common agreement with the Federal Government where leases in the disputed zone are involved). The State Wildlife and Fisheries Commission is concerned primarily with pollution and geophysical activity and agents of the Commission witness all explosive seismic operations.

The Louisiana Commissioner of Conservation determines the proration of allowable production among all of the wells in the State according to the current market demand. Louisiana and Texas are the only States in which market proration is important since most other States are deficient in petroleum or have adequate outlets for all that they produce. The Louisiana Conservation Commission determines the market demand by consumer nominations and sets the total daily allowable accordingly. This allowable is then allocated back to the individual wells based upon well capacity and the drilled depth of the well.

Louisiana recognizes the higher cost of marine development by granting larger production allowables for offshore wells according to an equity allowable ratio. Coastal wells have an equity ratio of 1.3 and offshore wells have an average ratio of 1.7. This means that offshore wells can produce 70 per cent more than an equivalent well would be allowed onshore. This ratio was established in 1953 when drilling was in very shallow water and close to shore; it has not been modified since that time even though wells are now being drilled nearly 100 miles from shore and production has been established in 340 feet of water.

State offshore administration in Texas is organized generally similar to that in Louisiana. The Texas Railroad Commission has the same general functions as the Louisiana Department of Conservation, evaluating drilling operations and setting production allowables. The Commission is also involved in pollution control, safety, and other normal aspects of supervising petroleum operations. The Texas Land Office has authority similar to the Louisiana State Mineral Board and is responsible for leases, lease sales, and exploration permits.

The State Oil and Gas Board is the primary agency administering petroleum operations in Mississippi. Geophysical permits for offshore work must be obtained from the State Marine Conservation Commission. Alabama's Department of Conservation and Florida's Board of Conservation regulate petroleum operations in the areas under their jurisdiction.

City and county governments also can have a significant influence locally on offshore petroleum development. Nearly all marine operations require shore-based facilities and accommodations. Through zoning regulations local planning boards may prohibit necessary storage or loading facilities, often requiring additional pipelines and onshore rights-of-way. Some of the coastal cities in California have ownership of submerged lands extending out to the three-mile limit. One of the largest oil fields in the United States, the offshore East Wilmington field, is owned jointly by the City of Long Beach and the State.

In addition, California in particular has established numerous "sanctuaries" specifically to prohibit development of offshore oil and gas resources in State waters. In at least the case off Santa Barbara, the Federal Government has honored these "sanctuaries" by establishing an adjacent "buffer zone" in Federal waters where no leases are being offered.

Recommendation:

Due consideration should be given to the total resource potential of a given area before it is set aside for any single specific use. Additional cooperation and understanding between industry and the Federal and State governments are necessary to facilitate the multiple-use approach to all offshore areas.

B. Federal Regulation

The Federal Government, under the Submerged Lands Act, recognizes State ownership of marine minerals to a distance of three nautical miles from the coast line, with certain exceptions: Texas and Florida have established historical ownership out to three leagues (10.5 statute miles) on the Gulf coast, and Louisiana also claims rights to three leagues. The Outer Continental Shelf Lands Act of 1953 delegates to the Secretary of Interior the major responsibility for all oil, gas, and mineral resource development on the Outer Continental Shelf (OCS), which lies seaward of the boundary of State jurisdiction. The seaward limit of the Outer Continental Shelf is not defined by this Act. Two Bureaus of the Department of the Interior prepare rules and regulations and supervise operations: the Bureau of Land Management is responsible for leasing OCS areas and the Geological Survey is responsible for regulation after leasing, as well as for all geological and geophysical exploration.

The Department of the Interior, through its Bureau of Land Management, accepts nominations for specific areas and determines when lease sales are to be held, which leases will be offered, and for which OCS areas. Leases are issued by competitive sealed bids on a cash bonus basis, with a fixed royalty rate of 16-2/3 per cent (although the minimum royalty allowed by the OCS Act is 12-1/2 per cent) and a size normally of 5,760 acres (a square of three miles on each side). The primary term of the lease is for five years and so long thereafter as oil or gas is produced in paying quantities. Each successful bidder must furnish an OCS bond for $100,000. The Bureau of Land Management is also responsible for controlling pipeline rights-of-way.

It is difficult for many companies to maintain a broad base in exploration and production activities with the very large budgetary and manpower commitments presently imposed by the irregular offshore lease sales.

Recommendation:

A firm schedule of lease sales, fairly evenly spaced and with more advance notice time than at present, would permit more orderly longer range planning by the industry. Within limits dictated by its own need for flexibility, the Federal Government should provide such advance information.

The Geological Survey regulates and supervises all drilling operations, including casing programs, completion or abandonment programs, and all production facilities. The Geological Survey also controls well spacings and all production procedures and determines acceptable gas-oil production ratios. This bureau regulates unit agreements between operators for the coordinated production of a single field and collects all lease rentals and production royalties. It controls and issues permits for all offshore geological and geophysical surveys (coring programs presently are not permitted in the Gulf of Mexico in waters less than 600 feet deep) and for all drilling operations. It has responsibility for pollution regulation in exploration and production operations as well as for safety regulations and inspections. Federal offshore production will be controlled by the Geological Survey off the West Coast by authorizing maximum efficient rates of production.

Other Federal agencies are also involved in regulating marine petroleum operations. The Coast Guard is responsible for safety at sea and the seaworthiness of vessels, including personnel requirements, emergency equipment, warning lights and fog alarm devices. The Coast Guard requires notification of location of drilling and producing platforms and publishes these in the "Notice to Mariners." It also patrols seaways for indications of pollution.

The Corps of Engineers of the U.S. Army also issues permits for geological and geophysical exploration, as well as for the construction of drilling platforms or islands. The Corps is generally concerned with obstructions to navigation, and requires notification of drilling locations. The Corps also effectively controls the location of shipping fairways and anchorage areas through its supervision of construction permits.

Although the Bureau of Commercial Fisheries and the Bureau of Sport Fisheries and Wildlife have no direct voice in marine petroleum operations, their influence is effected by cooperative agreements between these bureaus, the Geological Survey, and the Bureau of Land Management. These agencies are concerned primarily with possibilities of pollution, use of explosives at sea, and obstructions to fishing.

The Department of Defense also indirectly exerts control over offshore petroleum operations. Large and irregular amounts of shelf areas are reserved for such military purposes as practice bombing and missile areas. Submarine monitoring systems have been installed along various coasts and the appropriate authorities require notification of all offshore operations and often require permission for geophysical surveys and drilling operations.

The Federal Water Pollution Control Administration is concerned with possible pollution from all sources and maintains agreements with similar State groups and other Federal agencies in preventing and treating marine pollution.

The Federal Power Commission regulates and controls all agreements on prices to the producer, and controls transmission of all natural gas which originates on Federal leases or which passes through interstate pipelines.

In general, the administrative authority and procedures in Federal offshore areas are merely an extension of similar authorities and procedures onshore. The principal exceptions are that leases can be acquired only by competitive sealed bids and customarily carry a one-sixth royalty. The Federal policy has been generally to follow State regulations in waters off those States where there is no conflict in requirements, such as in proration and equity ratios. However, the Federal Government has recently indicated that it may assume proration regulation of Federal offshore leases, a factor which has led to conflicts with State regulatory agencies.

As of September 1967, a total of 1,220 Federal offshore oil and gas leases had been issued, aggregating about 5.5 million acres, and yielding lease bonuses of nearly $2 billion and rentals of $17.5 million. Some of the leases are more than 100 miles from shore and others are in waters as deep as 1,800 feet. The Department of the Interior has authorized geophysical surveys well beyond the topographic limits of the Continental Shelf and has issued permits for at least 100 core holes to be drilled on the continental slopes of the Gulf of Mexico and Atlantic seaboard in water depths of

600 to nearly 5,000 feet, with penetrations into the sea floor of up to 1,000 feet as limited by the Geological Survey. These investigations were not undertaken by the petroleum companies to search for oil or gas accumulations but merely to obtain a better understanding of the geology of these remote and unknown areas.

C. International Regulation

There is no reason yet to expect that oil and gas accumulations will not be present beneath the waters overlying all of our continental margins. This will be tested as technology advances.

Recommendation:

An international legal regime is needed that will provide protection for the petroleum explorer in waters seaward from the 200 meter isobath. A regime that the panel believes to be satisfactory is described in detail in the report of the International Panel.

VI. FUTURE IMPROVEMENTS IN MARINE PETROLEUM CAPABILITIES

As mentioned earlier it is likely that future advances in the technology of developing marine oil and gas resources will continue to be evolutionary, rather than revolutionary. Each innovation in industry in the past has been based on data and experience obtained by working in the sea and by careful engineering studies. This pattern can be expected to determine future developments. Not only must these advances be workable and practical, but they must also be economical. The petroleum industry has developed the present technological capabilities and it is not expected that future advances will depend in any significant way on outside developments. All aspects of marine petroleum operations are continually under study and research within the petroleum industry.

A. Future of Exploration

The capability exists now to conduct geophysical surveys in water of any depth, anywhere in the world. It is unlikely that any revolutionary new technique will be developed in the near future. Most effort will be devoted in improving efficiency and reliability of present tools, reducing the cost of data collection, and improving the useful speed under which surveys can be made. Specifically, in seismic work additional new energy sources will be developed, improved geophone systems will be used and digital treatment particularly of single-trace systems will be better developed. New and more sensitive ship-borne gravimeters will be developed. Many companies are now studying integration and computer treatment of all data while underway at sea.

Similarly, shallow coring can now be done in any water depth with existing drilling tools and vessels. The effort here will be to continue to increase mobility and decrease costs for such sampling operations. Techniques to permit limited hole re-entry without riser pipes between the vessel and the sea floor have already been tested. Several types of sea-floor, hard-rock coring devices have been built, but none is yet completely satisfactory; it is possible that such a practical device will be developed in the future. Because of their high cost and the inherently restricted area that can be studied, submersibles are considered to have no broad value in future oil and gas exploration. Similarly, such tools as reconnaissance satellites are expected to have no important influence on future marine petroleum developments.

B. Future of Drilling

As mentioned earlier, if the need existed and costs were not a problem it would probably be possible to drill an exploration or development well in almost any water depth. The critical technological problem is really one of doing the task economically. Many of the floating drilling vessels now working throughout the world are capable of drilling in water depths up to 600 feet and most of the newer ones are designed to drill in at least 1,000 feet of water. Economical and practical riser-pipes and riser-handling procedures have yet to be tested.

It is likely that there will be even a greater variety of drilling vessels in the future, to meet a greater variety of needs. It is also probable that operations aboard the vessel, while drilling, will be increasingly automated in order to improve safety, increase operating rates, and reduce delay times. Improved dynamic positioning systems and better adjustable anchor systems will also become available.

All of these deeper-water drilling problems are presently under study within the petroleum industry. The fact that several leases off southern California have just recently been bought in up to 1,800 feet of water suggests that we may see such deep-water drilling within the near future.

C. Future of Production

Drilling and exploration capabilities appear to be more advanced for deep-water areas than are the production capabilities; this is certainly to be expected since exploration and drilling must necessarily precede production. Fixed production platforms have been installed in 340 feet of water and some engineers believe that such platforms are practical throughout the Continental Shelf to water depths of at least 600 feet. Other engineers believe that sea-floor completions will ultimately be more practical and more economical beyond water depths of about 350 feet.

Several sea-floor well completions have already been made, as noted earlier, and again it would probably be possible with present technology to complete wells in great water depths in the near future if economics were not critical. The industry has already devoted considerable effort toward studying and developing methods for sea-floor well completions, production and gathering techniques, separation, treatment and storage facilities. This work is actively continuing.

It is difficult to predict which deep-water system will ultimately prove to be most practical, but it is likely that several different techniques will be employed. Many studies and successful tests have already been made for servicing underwater wells with remotely-controlled televiewing robots, with "through-the-flowline" treatment tools, with hydraulically controlled surface lines, and with acoustically controlled valving systems operating from conventional and nuclear energy sources. The use of divers is being extensively investigated and long-term studies are already underway regarding the usefulness of a variety of submersibles.

Submersibles capable of doing useful work have been developed by private industry, and most of them were developed entirely with private funds. This is also true of manned diving capabilities. Recently a private diving firm demonstrated that useful work could be done at water depths in excess of 1,000 feet. It appears that a large part of the impetus for such private developments has been the stimulus, future need, and encouragement provided by the petroleum industry.

D. Future of Transportation

The cost of offshore pipelines is very much higher than similar facilities onshore. However, where such costs become prohibitive, surface transportation by barge or tanker is already economical, at least for crude oil. The major problem is providing economical offshore storage and loading facilities. Isolated offshore production facilities are being studied by industry and a variety of types have been successfully installed in several parts of the world. Undoubtedly, the future will bring significant improvement in the technology and economics of such production facilities, as well as in methods for sea-floor and sub-bottom storage.

Offshore natural gas presents a distinctly more difficult problem since gas pipelines are larger, more expensive, and more difficult to lay than are petroleum lines. The only method to transport natural gas by barge is with a complicated and expensive cryogenic system capable of reducing the gas to a liquid, which would also require large and expensive offshore installations. In both instances the technology is largely already available, but the economics of both are apt to be prohibitive. It is difficult to predict what future advances might become available to allow production of natural gas from great water depths or great distances from the shore.

E. Pollution Control and Prevention

The petroleum industry appears to be seriously concerned about water pollution problems of all types. It is presently investing large amounts of money in research on pollution control and prevention and in actual improvements and modifications of equipment and operating techniques. There is no doubt that the Nation's desire to control marine pollution within acceptable limits is important and should receive high priority in the National oceanic program.

Careful joint studies have been made in the past—by the industry and the Federal Government—of reasonable limits and practical means for pollution control. A recent example is the study prepared for the President[18] by the Departments of the Interior and Transportation in consultation with other Federal groups, with knowledgeable representatives of the petroleum and other industries, and with representatives of coastal States.

Joint efforts of this sort directed toward practical pollution control should be actively continued. Criteria should also be established for the various users of bays, estuaries, and rivers so that individual States will have accurate information on which to establish effective, realistic, and comparable pollution standards.

VII. RELATIVE ROLES OF INDUSTRY AND GOVERNMENT

A. Relative Role of Industry

The role now being played by the integrated petroleum company in exploring, developing, producing, shipping, and marketing offshore oil and gas is well known and there is little need to discuss it here. It might be worthwhile, however, to point out the role successfully being played by the many contracting and support companies.

Fifteen years ago there were no offshore drilling contractors. Today these firms own and operate hundreds of millions of dollars worth of equipment in every ocean of the world. Whatever the fortunes of individual companies, it is certain that marine contractors as a whole will be operating several times as much equipment in the near future. These companies, and the operating companies, also require support from a variety of other specialists: companies to provide boat and helicopter transportation needs throughout the life of a field; services and equipment such as drilling mud, machinery, and various completion techniques. All of this is commonly preceded by other contracting companies specializing in particular exploration techniques. In this way, the petroleum industry as a whole is able to maintain a very large number of special capabilities and an even larger number of technically competent people.

Also, little has been said regarding the large amount of research and development being carried out by both the large petroleum companies and the contracting companies. All major oil companies maintain large research laboratories and field facilities to develop and test new scientific technological tools and concepts and many significant advances have been made by the service companies—again, because of economic incentives sufficient to justify these efforts. Not uncommonly, a new technological advancement will yield no unique competitive advantage to a particular company, but if perfected it would be of value to the industry as a whole. In these cases various combinations of major companies, or of contracting companies, or both, will be formed in order to take maximum advantage of individual capabilities. Each of these successful efforts helps to reduce the cost of developing petroleum at sea. In 1966 alone, the oil and offshore industry spent over $30 million on research and development in support of offshore operations. A 1967 estimate runs to $50 million and it has been estimated that close to $100 million will be spent for research and development five years from now.

Thus, the present role of the petroleum industry is not merely one of exploring and developing domestic marine oil and gas resources, but also one of maintaining a large and diverse specialized capability in broader offshore operation, as well as one of conducting extensive research and development in improving future capabilities. The industry brings to offshore development a vast network of refining, distributing and marketing facilities on land, together with a century of experience in developing land resources and an extensive background of exploration and development in all of the world's oceans. As long as the economic incentives are adequate there is little doubt that the petroleum industry will be able to continue its present role in developing marine oil and gas resources.

B. Relative Role of Government

Navigation charts and traffic control services are always of value, but many operators still prefer to contract in many areas for private navigation facilities. Even though most operators also employ private weather forecasting services, the basic weather data collected by the Government are of value to all operators. Federal research into prediction (and perhaps eventual control) of such major storms as hurricanes is of potential value to all operators, as is research on measuring and predicting sea-state conditions. Control of traffic at sea has successfully been worked out in the past by the various users and the Government. These efforts should continue as marine traffic continues to increase.

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[18] Secretary of Transportation, *Oil Pollution, A Report to the President*, (Washington, D.C.: U.S. Government Printing Office, 1968).

Recommendation:

The navigation charts traditionally prepared by the Government should continue to be updated on a timely basis. In addition, the general bathymetric mapping of the adjacent continental shelves, slopes, and rises by the Federal Government should continue at present or at greater levels of activity.

The study of important sea-state and weather characteristics, such as wave height and frequency spectra, wave data, severe storms, and large stormy recurrence characteristics, should be accelerated. Forecast needs include wind, wave, and sea-state predictions. Studies in the control and dissipation of major storms should continue.

Exchanges of potentially useful data between both Government and the industry has been accomplished in the past, but only very poorly. This may be due in part to the complexity of organizations in both groups, but a means for jointly improving this exchange should be studied further. While most of the industry's technology is developed "in-house," Federal technology developed for other purposes can sometimes be of value. An example is the Navy's Transit satellite navigation system, now available for non-military uses. Hopefully, additional satellites can soon be put aloft to allow more frequent and more accurate navigational fixes.

Recommendation:

The timely release and interchange of technological and research data between the Federal Government and the petroleum industry should be improved. A committee of appropriate agency and industry representatives should be formed to determine the most expeditious means for dissemination of such information.

An important aspect of Federal and State administration has been the general reluctance by Government to set aside offshore areas for exclusive single-use purposes. In most instances the successful future development of our offshore resources will be best served by employing the multiple-use approach, but in some cases the single-use approach will be appropriate. In most cases there is actually little need for single-use restrictions; continuing technological advances have increasingly made multiple-use applications not only practical but desirable.

The geological mapping and research traditionally carried out on land by the Geological Survey has always been of value to the petroleum industry as well as to the Federal Government. This traditional role is more difficult to define in the offshore areas. The Geological Survey has carefully avoided doing extensive geophysical work or drilling in sedimentary basins on lands, where the oil industry concentrates its efforts. However, this is the only feasible way that geological studies can be conducted offshore. The reaction within industry to such studies appears to be mixed–favored by some, opposed by others, very broad scale only, moderately broad scale acceptable, surficial deposits only, etc.–but all agree that detailed expensive surveys by Government should not be undertaken as long as leases are let only by competitive sealed bids. Proprietary geological knowledge becomes of great importance and value to companies in preparing for such lease sales and it is for this reason that many companies object to Federal surveys offshore.

In any case, expensive reconnaissance geological studies of even the deep-water parts of our continental margins have been and are actively being pursued by the industry, and it is unlikely that similar broad-scale surveys by the Federal Government would accelerate development of our marine petroleum resources. However, such studies are of great value to basic science and may also aid in efficient administration of these resources. Public funds should not be used to undertake surveys or studies which industry is willing to do, already equipped to do, capable of doing, or has already done at its own expense.

Recommendation:

Broad reconnaissance geological studies of our continental margins, supported by the Federal Government, should continue in order to add to

scientific knowledge and to provide a knowledgeable basis for administering resource development. The Government should not support or undertake those detailed surveys or other studies which industry is already equipped and willing to do at its own expense.

Nearly all of our present understanding of the fundamental geology of continental margins and other marine areas has resulted from the pioneering marine studies conducted by oceanographic and other academic institutions. This work forms the fundamental foundation for interpreting all other marine surveys, and it continues to be of basic importance to predicting and interpreting offshore potential for all mineral resources.

The marine surveys conducted by academic institutions are distinct from systematic surveys of offshore areas in that they are devoted to solving specific problems in marine geology that commonly have wide application. The bulk of these studies are supported by Federal grants and such support should be actively continued or even expanded.

Recommendation:

The marine geological and geophysical surveys and scientific studies historically conducted by oceanographic and other academic institutions should continue to be actively supported through Federal funding.

FINDINGS AND RECOMMENDATIONS

Alternative fresh water resources that may be available in coastal areas include:

–Surface water from coastal lakes, estuaries, and up-river reservoirs or lakes with pipelines.

–Groundwater from onshore aquifers that may extend beneath the sea, offshore aquifers isolated from hydraulic continuity with onshore aquifers, and aquifers containing fresh water "manufactured" in sediment compaction processes (a hypothesis at present).

–Desalted water obtained from seawater of high salinity or from brackish surface or groundwater.

The naturally fresh water from surface and underground sources have been and will continue to be of major importance in supplying coastal areas; they will be only briefly discussed. Desalted water from the sea is growing in importance as an alternative or supplemental source of fresh water in coastal areas faced with shortages of reasonably priced conventional water; it is an important marine resource. Principal attention here is given to desalted water.

The greatest demand in the near future will be for desalting plants of less than 10 million gallons per day capacity. Many of these plants will probably be used in special situations; the plant at Guantanamo, Cuba is an example. Desalting technology appears to be advancing at a satisfactory rate to meet whatever requirements may arise in terms of demand for small plants, as well as for larger plants (50 - 100 mgd) in the future.

There is a need for continued study of various desalting processes since no one process will be able to fulfill all of the requirements for desalting. A serious question that requires continuing study is how the Government's research and development effort should be apportioned to the various desalting processes. More comprehensive data on potential applications of desalting are needed to improve the Government's desalting development efforts in a realistic manner to meet future desalting requirements in terms of processes, plant capacities, occurrence of saline water resources, and the periods of need.

Little is known concerning the effects on ecology and environment of prolonged discharge of heavy volumes of heated brines into coastal waters. It is probable that some effects will be beneficial and some will be harmful.

Recommendation:

A thorough study should be made of possible effects of prolonged release of thermal brines on the ecology and environment as soon as possible after the site is selected and before large-scale plants are built. Detailed studies relating to these aspects should continue after a large scale desalting plant is constructed. Ecological and other changes resulting from its operation should be carefully studied and documented.

Ideas have been developed recently regarding the possibility of subsurface fresh water offshore that may not be directly connected with the present terrestrial hydrologic or gravity system. On the Gulf Coast in Louisiana and Texas, for example, there seems to be both fresh and highly saline water in permeable stratigraphic units occurring under much greater pressure than can be accounted for by the gravity of the circulation system.

Theoretical considerations suggest that through compaction processes, and later through osmotic membrane phenomena, there may be a separation process in which highly saline water is concentrated in some permeable sands and relatively fresh water is accumulated in others or in different parts of the same aquifers. These processes, in effect, may be manufacturing "new" fresh water. If so, there may be sizeable sources of fresh water at considerable depth beneath the sea in certain coastal areas that could be extracted for beneficial use.

Recommendation:

A definitive program of research should be undertaken to appraise the possibility of water offshore "manufactured" during compactional processes. The critical objectives should be to find out

whether the process actually exists and, if it does, whether the rate of manufacture is fast enough to make large quantities of water available. Such a program should include laboratory research into osmotic membrane phenomena under offshore geologic conditions, collection and analysis of deep sediment cores and interstitial waters, and offshore test drilling in selected localities.

I. PRESENT LEVELS OF FRESH WATER UTILIZATION

It is estimated that, on the average, 700 billion gallons of water per day (bgd) flows into the oceans from the U.S. land. The current U.S. demand is on the order of 370 bgd, and the estimated use by the year 2000 will approximately double.[1] Because most water is returned to the system in some way the figure for consumptive use becomes the critical one. It has been estimated that consumptive use will increase from about 80 bgd in 1965 to 130 bgd in the year 2000, and around 175 bgd by the year 2020. Because of the need to maintain some water in channel flow, the unequal distribution of water in time and space, and the decrease in water quality resulting from use, these figures indicate a potential deficiency in available fresh water.[2]

II. DEMAND PROJECTIONS

About 75 per cent of the present U.S. population lives in the 30 States bordering the oceans and the Great Lakes, and this geographic segment of the population is growing much faster than any other. Demographers anticipate that by the year 2000 the most densely populated region of the United States will be a megalopolis along the Atlantic coast between Portland, Maine, and Savannah, Georgia. Other areas of great population will extend along parts of the west coast and along the Great Lakes. Thus, water requirements in coastal areas will rise much faster than for the country as a whole. Meeting these demands will probably not be difficult on the east coast and the eastern part of the Gulf coast where a humid climate prevails and an ample supply of fresh water from conventional sources is generally available. However, in the dryer western part of the Gulf and along the southern segment of the west coast the problems of meeting the demand will become increasingly difficult.

III. ALTERNATIVE SUPPLY PROSPECTS

It is beyond the scope of this report to analyse intensively the many complex problems relating to water resource allocation and utilization, present or future. The intent here is to show that waters of the marine environment may be important alternative or supplemental sources of fresh water in coastal areas faced with shortages of reasonably priced conventional surface and ground water.

Potential marine sources include submarine aquifers some of which may contain "new" fresh water being manufactured by processes as yet unknown or understood; more efficient use of ground water supplies from aquifers that slope beneath the sea; and desalted sea water. Principal emphasis here is on desalted sea water which is becoming increasingly important as advances are made in desalting technology. Any coastal area faced with a fresh water shortage now has the alternative of building a desalting plant; in previous years the only solution would have been to divert water from another, perhaps distant, area of surplus. In choosing between the alternatives of desalted water and diverted water the most important factor is cost.

A. Water Diverted from Areas of Surplus

The fresh water resources of the United States are very unevenly distributed geographically. Transfer of water from areas of surplus to areas of deficit is one alternative method to fill the needs of the deficit areas. However, such transfer raises important economic, social, political, and legal implications that need careful study; not the least of these is whether the interregion transfer is the least cost alternative.

B. Submarine Aquifers[3]

Two possible sources of fresh water from so-called submarine aquifers are:

–Certain aquifers beneath the land extend beneath the sea. They include aquifers off the open coast as well as those that lie beneath estuaries and other relatively small coastal ocean-water bodies. They also include aquifers or parts of aquifers in geologic formations extending some distance seaward from the coasts, but which may be cut off from land recharge by clay beds or faults.

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[1] Department of the Interior, "Marine Resources Development–A National Opportunity" unpublished report, 1968.

[2] Arthur M. Piper, "Has the United States Enough Water?" Geological Survey Supply Paper No. 1797, 1965.

[3] Summarized from information supplied by the Geological Survey, 1968.

–There is some suggestion that fresh water in deposits offshore may originate from processes involved in compaction of sediments and where the water is genetically unrelated to the land hydrologic system. This may be considered as a source of "new" water.

Extensive aquifers of the first type occur along the middle and south Atlantic coasts and the Gulf Coast; elsewhere there are few possible aquifers worth exploring. The reason is that the rocks lack permeability or that the outcrops are too narrow and extend relatively short distances offshore. All these aquifers contain fresh water in their landward parts and salty water in their seaward parts. The boundary between the two waters can be either onshore or offshore. The parts of these aquifers that contain fresh water do not constitute a "new" source of water. This does not mean that the aquifers might not be utilized more efficiently and more water taken from them. Typically, plans for more efficient management would be based on a determination as to the maximum rate which fresh water could be pumped without inducing encroachment of salt water; or, where encroachment could not be prevented at the desired withdrawal rate, prediction of the rate at which salinity would increase so that appropriate treatment and processing techniques could be scheduled.

C. Desalted Water

Sea water or other saline waters may be converted to fresh water by one of several processes that either remove the sweet water from the salt solution, or remove the salts from the solution. In either case, a brine that is more concentrated than the salt solution fed into the conversion plant is a coproduct with the fresh water and must be disposed of.

Some methods of producing fresh water from salt water have been known for centuries; other methods have been developed only very recently. The costs and rate of conversion of water vary widely among the processes. Of the processes that are now actively being studied and developed in the United States some are now utilized commercially, some are in the pilot plant stage, and others are being studied in laboratories.

Conversional processes may be divided into four broad categories:[4]

–Distillation or evaporation processes, which involve the conversion of salt water into sweet water vapor and then its condensation. The major process types in this group being investigated under the Office of Saline Water (OSW) program are:

a) multiple-stage flash (MSF) distillation;
b) vertical tube evaporation (VTE);
c) vapor compression;
d) liquid-liquid heat transfer;
e) multi-process systems.

–Membrane processes, which employ methods by which diffusion proceeds through use of a semipermeable membrane. Salt and water are separated while still in a liquid state. The major process types being investigated under the OSW program are:

a) electrodialysis (ions pass through);
b) reverse osmosis (water passes through);
c) transport depletion;
d) electrosorption and desorption;
e) forced flow transport depletion.

–Crystallization processes, which involve the separation of pure water solids (ice) from a salt solution. The major types being investigated under the OSW program are:

a) vacuum freezing vapor compression;
b) order of melting inversion.

–Other processes. Within the last 10 years OSW has investigated some 47 processes, of which all but 15 have been eliminated because they were not economically competitive with other desalting systems. In addition to those mentioned previously, studies are continuing on conventional ion exchange, conventional reverse osmosis, thin channel reverse osmosis, and pressure dialysis.

Expenditures of OSW on desalting research and development from FY 1953 through FY 1968 amounted to about $118 million, of which about

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[4] Summarized from information supplied by the Office of Saline Water, Department of the Interior, 1968.

38 per cent was spent on distillation processes, 15 per cent on membrane processes, 13 per cent on freezing processes, and 34 per cent on general research.

The general trend of OSW expenditures is shown in Figure 1. Funding remainded at a low level during the 1950's, but has been much more substantial since 1960.

The distillation processes which afford a user a proven sea water desalting process are the most technologically advanced.[5] These processes are adaptable to production of water in small plant sizes (1-5 mgd) as well as plants producing hundreds of millions of gallons per day. At present, major research emphasis in the field of distillation is on the development of corrosion-resistant materials that maintain their requisite heat transfer properties, and the development of methods for minimizing or eliminating compounds that increase corrosion and form scale such as calcium sulfate.

The Office of Saline Water has recently completed what is termed a "Universal" 2.5 mgd plant design. The purpose is to develop a sound basis for the procurement of high quality plants.[6] The heart of this effort is the development of a performance specification, procedures for procurement, and recommended warranties for such a plant.

The OSW also has a considerable effort in developing large plant concepts, combination processes (MSF-VTE and others), and supporting development work.

An aggressive research effort is being made in the broad area of membrane processes. Major emphasis is placed by the Office of Saline Water on the reverse osmosis process which involves the use of a permselective membrane which allows the

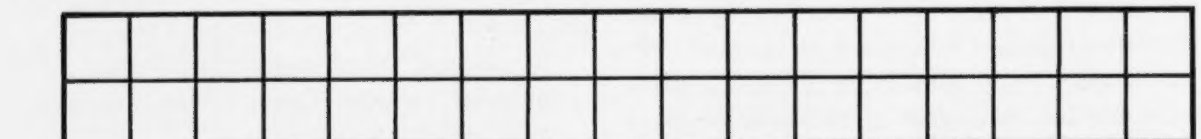

Figure 1. *Approximate expenditure breakdown of OSW activity since 1953 into major process categories.*

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[5] J. A. Hunter, "Advances in Desalting Technology" (International Conference on Water for Peace, Washington, D.C., May 1967).

[6] *Ibid.*

selective passage of water, with rejection of salts and other pollutants through the membrane under an applied pressure in excess of the osmotic pressure of the saline feed. The second major membrane process, electrodialysis, involves the selective passage of ionic salt species through alternating pairs of cation and anion selective membranes under the influence of an electrical potential. This process may be economical for brackish waters and a major research effort is to develop new and improved membranes which are more resistant to fouling by various pollutants.

Newer ion exchange processes, such as Sul-by Sol, Sirotherm, and Kurnin, developed by private industry, may be competitive with reverse osmosis and electrodialysis.

Crystallization processes are also being investigated. The vacuum freezing-vapor compression method appears especially promising, and pilot plants utilizing both seawater and brackish water are in operation. Investigations are also continuing on the order of melting inversion process. Hydrate and secondary refrigerant processes have been found to be uneconomic and efforts to develop them have recently been curtailed.

On Jan. 1, 1967, there were 153 seawater-based plants of all types in operation, of which 28, with a desalting capacity of 15.1 mgd, *were in the United States.*[7] At the end of 1967 a total of 625 desalting plants with a combined capacity of 222.2 mgd were in operation or under construction worldwide (Table 1). It is not known how many of these are seawater-based plants.

Five operating plants in the United States have capacities of one mgd or greater; the largest, placed in operation in 1967, is in Key West, Florida and has a capacity of 2.6 mgd. Three of these five plants are OSW test bed plants. About 95 per cent of all plants now in operation use the multiple stage flash distillation process.

A strong market is seen for small scale desalting plants (less than 10 mgd) over the next decade[8] for the smaller metropolitan areas. Demand, over the near term at least, will probably be mainly for industrial and metropolitan uses.

Table 1

DISTRIBUTION OF DESALTING PLANTS AND PLANT CAPACITY IN OPERATION OR UNDER CONSTRUCTION, BY GEOGRAPHICAL SUBDIVISION AS OF DEC. 31, 1967

(producing 25,000 gallons per day or more)

Sub-Division	Continent or country	No. of Plants	Total plant Capacity
1	United States	286	39.5
2	U.S. Territories	15	7.5
3	North America except U.S. and its Territories	11	8.4
4	Carribbean	24	16.9
5	South America	20	3.7
6	Europe (Continental)	77	26.3
7	England and Ireland	62	14.1
8	Australia	7	1.9
9	Asia	18	2.1
10	Middle East	63	50.1
11	Africa	35	10.8
12	Union of Soviet Socialist Republics	7	40.9
	Total	625	222.2

Source: Office of Saline Water, Department of the Interior, June 1968.

According to the Office of Saline Water,[9] 43 new desalting construction starts were made, worldwide, in 1967. Of these, four will have a desalting capacity between 5 and 10 mgd, and nine will have a capacity between 1 and 5 mgd.

During the period 1960-1965, worldwide desalting capacity showed an average annual growth rate of 12 per cent. Tentative OSW projections indicate an annual growth rate of 24 per cent during the decade 1966-1975, and 32 per cent during 1976-1980. Capacity is projected to grow from 222 mgd on Jan. 1, 1968 to 1.0 bgd by the end of 1975, and to 4.0 bgd by the end of 1980.

IV. UNIFORM COSTS COMPARISONS

In 1952, when only a few small land-based desalting plants were in existence, the cost of

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[7] Information supplied by W. F. McIlhenny, Dow Chemical Corp., February 1968, adapted from the 1966 Saline Water Conversion Report by the Office of Saline Water, Appendix E.

[8] Conversation with J. A. Hunter, Office of Saline Water, Department of the Interior, 1968.

[9] Written communication, July 1968.

Table 2
CONTEMPLATED NEW PLANT CONSTRUCTION FOR DESALTING
(Greater than 10 mgd)

Location	Size (mgd)	Owner	Operation
Gulf of California	1000.0	U.S.-Mexico	–
Israel-Jordan	1000.0	Israel-Comsat-like Corp.	–
Bolsa Island[1]	150.0	MWD	1974
Almeria	130.0	Spain	1970
Donbass Region	130.0	U.S.S.R.	–
Sidi Kreir	100.0	U.A.R.	1970-1972
Athens	50.0	Public Power Corp.	–
Escombreras	26.0	Spain	1970
Kuwait	12.0	Kuwait	1970
Kuwait	10.8	Kuwait	1970

Source: *Water Desalination Report*, Vol. IV, No. 1, Jan. 4, 1968, p. 3.

[1] Alternative arrangements for this project are being investigated by the participants.

desalted water ranged upward from $4.00 per 1000 gallons.[10] By 1967, owing to improved technology, costs were in the range of about $1 per thousand gallons for plants of 1 mgd capacity. It is anticipated that during the period 1968-1972 desalting costs can be reduced to 50 cents per 1000 gallons for the one to 10 mgd plant size. In 1965, it was claimed that large plants of 50 to 150 mgd capacity such as that planned for Bolsa Island off Huntington Beach in southern California could produce desalted water for 20 to 30 cents per 1000 gallons within five years. However, owing to higher plant construction costs the Office of Saline Water has recently revised this figure upward to the range of 35 to 37 cents per 1000 gallons.[11]

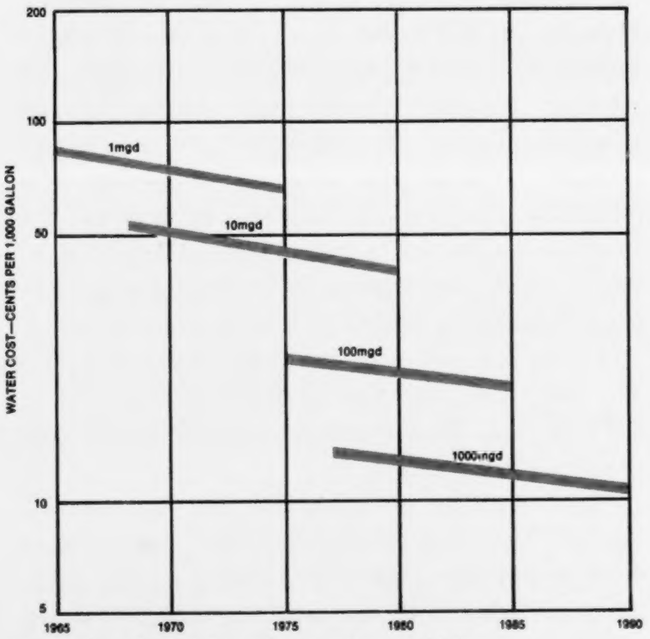

Figure 2. *Projection of sea water desalting costs for a range of plant sizes. Based on: distillation technology, 6 per cent fixed charge rate, U.S. construction and operation, dual purpose plants, most probable energy costs, and 1966-1967 price index. Source: Office of Saline Water, Department of the Interior.*

The feasibility of constructing a desalting plant at any particular site is dependent in large part on the cost of alternate sources of water such as that diverted or transferred from areas of water surplus. Few detailed studies of relative costs in real situations are available.

However, a study of costs, completed in November 1966 by the Southwest Research Institute for OSW, provided useful data for comparisons. Thirty-seven cities in Texas with 1,000 or more population were identified by a careful screening process to have present or potential municipal water supply problems; a detailed analysis of alternative water prospects was considered necessary. The 37 cities are widely scattered over the State but about half are within 100 miles of the Gulf of Mexico in the southern part of the State. On the basis of a unit cost comparison between desalting and the cost of providing water supplies from the least expensive conventional source eleven cities were identified as representative of those which could benefit from a desalting plant.

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[10] The 1967 National assessment of water and related land resources.

[11] Conversation with J. A. Hunter, Office of Saline Water, Department of the Interior, March 1968.

Six of these were within 100 miles of the Gulf and the remaining five were scattered far inland. In each of the 11 cities the unit cost for desalting water was found to be less or about the same as the unit cost for water from conventional sources.

Twenty-six cities were eliminated from further consideration because it was found that the calculated unit costs for desalted water from individual plants was significantly higher than the unit costs for conventional water. Nine of these 26 cities are in close geographic proximity in the lower Rio Grande Valley and have similar water problems. They provide a case for further study because of the possibility of obtaining economical municipal water supplies from one or more large desalting plants instead of many smaller ones.

A comparison of unit costs for the 11 candidate cities is summarized in Table 3. The costs given are total costs. They include water production, transportation, treatment, and processing costs. In addition, for desalting, the cost of brine disposal is included. Although the cost data given are preliminary, pending detailed engineering studies for each city, the methods and technical data used in the computation are sufficient to establish a predictable range of accuracy plus or minus 10 per cent.

A comparison of capital costs of desalting plants versus conventional plants in the eleven candidate cities is given in Table 4. In favor of desalting in all 11 cities is the lower capital investment required for desalting as compared to development of conventional water supplies.

Southwest Research Institute points out that the cost of desalted water calculated for any of the Texas cities would prohibit its use as agricultural water. The least expensive desalted water calculated in the study was 30 cents per thousand gallons. Translated to a dollars per acre foot basis this water would cost about $98. In the lower Rio Grande Valley where the demand for irrigation water is great, the least expensive desalted water calculated for any city was 32.1 cents per thousand gallons which is the equivalent of $105 per acre foot. The current cost of irrigation water in the valley is $10 to $15 per acre-foot.

Table 3
COMPARISON OF UNIT COSTS OF DESALTING VERSUS CONVENTIONAL WATER SUPPLY SYSTEMS IN THE ELEVEN CANDIDATE CITIES

(Unit costs include capital amortization)[1]

City	Plant Size[2] MGD	Unit Cost, cents/1000 gallons	
		Desalting	Conventional
Beeville[3] . . .	3.3	30.0 cents	29.3 cents
Dell City . . .	0.2	144.2	212.0
El Paso[4] . . .	10.0[7]	54.5[7]	–[5]
Fort Stockton[3] .	2.2	37.1	33.7
Freer	0.4	55.6	90.5
Hebbronville . .	0.7	44.1	44.8
Italy	0.2	83.6	83.0
Kingsville[3,4] . .	2.0	38.1	35.6
Port Mansfield .	0.7	54.4	–[6]
Rankin[3] . . .	0.5	50.5	47.9
Refugio . . .	0.9	36.9	59.5

[1] Costs are expressed in dollars of 1966 value.

[2] Plant capacities based on projected 1985 municipal water requirements.

[3] Calculated at 750 parts per million total dissolved solids (ppm TDS) product water. All other cities are calculated at 500 ppm TDS.

[4] Incremental supplies for additional water requirements. All other cities are calculated for total water supply requirements for 1985 for both supply and quality improvement.

[5] Several alternate conventional sources of water supply for El Paso are under active consideration. The study of the feasibility of development of these sources has not progressed to the point where costs can be estimated.

[6] No proved alternate source of water supply with less than 1,000 ppm TDS is available to Port Mansfield, therefore no cost calculations were made for comparison.

[7] For plants in this size range, OSW has under development new types of distillation processes which may be expected to compete favorably with the electrodialysis plant concept for which this desalting cost was calculated. Preliminary estimates indicate unit costs as low as 48¢/1,000 gallons for the El Paso site.

It seems reasonably clear from the Southwest Research Institute study that in localities where special circumstances prevail and for uses where the value of the marginal product is high, desalted water can compete on an economic basis with water from conventional sources. But for agriculture, which has low marginal product value, the cost of desalted water, at least from plants in the 10 mgd size range, is not remotely competitive with conventional water. In calculating relative costs realistically it is important to prepare and analyse the schedule of the value of marginal product of water for various quantities that might be available to a region. There is also the need to compare marginal costs of desalting water and water from conventional sources.

An important item in connection with the comparison of water costs from desalination and costs from conventional sources relates to the

Table 4
COMPARISON OF CAPITAL COSTS OF DESALTING PLANTS VERSUS CONVENTIONAL PLANTS IN THE ELEVEN CANDIDATE CITIES
(thousands of dollars)[1]

City	Plant Size[2] (mgd)	Total Capital Costs		Desalting Capital Costs as a Percent of Conventional Costs
		Desalting	Conventional	
Beeville[3]	3.3	$1,662	$2,933	57%
Dell City	0.2	574	2,807	20
El Paso[4]	10.0	7,541	–[5]	–
Fort Stockton[3] . . .	2.2	1,151	3,051	38
Freer	0.4	444	1,663	27
Hebbronville	0.7	537	1,553	35
Italy	0.2	378	716	53
Kingsville[3,4]	2.0	1,173	2,375	49
Port Mansfield	0.7	583	–[6]	–
Rankin[3]	0.5	425	1,308	32
Refugio	0.9	630	2,311	27

[1] Costs are expressed in dollars of 1966 value.

[2] Plant capacities based on projected 1985 municipal water requirements.

[3] Calculated at 750 parts per million total dissolved solids (ppm TDS) product water. All other cities are calculated at 500 ppm TDS.

[4] Incremental supplies for additional water requirements. All other cities are calculated for total water supply requirements for 1985 for both supply and quality improvement.

[5] Several alternate conventional sources of water supply for El Paso are under active consideration. The study of the feasibility of development of these sources has not progressed to the point where costs can be estimated.

[6] No proved alternate source of water supply with less than 1,000 ppm TDS is available to Port Mansfield; therefore, no cost calculations were made for comparison.

present cost of incremental water supplies. The cost of new municipal water from conventional sources will be considerably greater than the average cost of water now delivered for these reasons:

–Equipment, labor, and construction costs advance; the factor of inflation is ever present and important.

–Adequate conventional water supplies become more difficult to secure and make available. Longer pipelines may have to be built, deeper wells drilled, more costly reservoirs built which increase the cost of water to the ultimate consumer.

–The acquisition cost of existing water sheds, pump stations, aqueducts, and distribution piping grids have been written off and are not included in water costs presently reported for the older water systems.

–To increase conventional water supply for heavily populated areas, such as the eastern seaboard megalopolis, additional prime land will have to be set aside for new reservoirs which during drought periods would still have difficulty meeting the increasing water demands. If this prime land is assessed at its true market value, the present tax and amortization rates should be applied in any comparison with desalted water.

Generally, the cost of desalted water should not be compared with the current cost of conventional water, but rather with the cost of providing new incremental supplies at today's construction cost level and with today's difficulties in securing new water supplies.

V. VALUE OF DESALTED WATER

Standard quality and reliability are two desirable attributes of desalted water. A third potential attribute is the mineral by-products that may be captured in the desalting process as technology advances.

The quality of water from a desalting plant can be depended upon to fall within certain limits, but the quality of many conventional water sources usually varies. The lower Colorado River water has a salinity or hardness of about 900 parts per million (ppm) while water produced from desalting plants using the distillation process has a hardness of only 5 to 10 ppm. For corrosivity reasons most or all distilled water will probably be mixed with natural water before use in a municipal system.

Hard water requires much more soap or detergent than soft water and is therefore much less desirable.

It has also been demonstrated that there is a relation between salinity of irrigating water and crop productivity.[12] Water of lower salinity produces better crops; this might be accomplished by mixing soft desalted water with the hard Colorado River water. A current cooperative study by OSW and the Bureau of Reclamation is aimed at determining in a quantitative fashion the value of desalting to irrigation.

Rainfall varies over the years and reservoir storage and release must be programmed to meet requirements of the statistically worst year. This means the water from conventional sources may have to be rationed at certain times. On the other hand, supply from a desalting plant utilizing sea water is constant, adding a value factor to desalted sea water.

A great many elements are present in minute quantities in sea water but only magnesium, bromine, and salt can be extracted commercially with existing technology. On the basis of estimates and processes now available it is improbable that more than a small minority of desalting plants will be able to realize any economic return from the recovery of by-product elements and compounds. However, the possibility of a technological breakthrough that will permit the economic recovery of by-product elements such as uranium, which is present in the amount of $339,000 per cubic mile at current prices, cannot be dismissed.

VI. COMPATIBILITY OF DESALTING PLANTS WITH ENVIRONMENT

A major problem, relating especially to large scale desalting plants, is the effect the disposal of large quantities of hot brines will have on the ecology and climatic environment of the nearby area. What will be the deleterious effects? What will be the beneficial effects? What will the net effect be? One study relevant to this problem has been completed by OSW. Other studies are currently underway in relation to the Bolsa Island plant (project cancelled) but results are not yet available. The total OSW budget for studies relating to brine disposal in estuaries and the ocean is about $200,000 during the current year.

Possibly a realistic evaluation of the brine disposal problem cannot be made until after a large plant has been in operation for several years. Nevertheless the problem of compatibility is of such importance that the most comprehensive study possible should be made before construction begins. A complete pre-plant ecological survey will be necessary for every large plant, and must extend over a sufficiently long time to cover all seasonal and periodic changes. Without this, no post-plant survey can have any meaning.

Engineering methods for minimizing the environmental effects of the discharges are available and should be incorporated in the plant design.

VII. PRESENT LEVEL AND STRUCTURE OF GOVERNMENT ACTIVITY

The Office of Saline Water of the Department of the Interior, established in 1952, has responsibility for encouraging, planning and administering research and development relating to desalting technology and associated problems. Essentially all technical studies and research are contracted with industry and research institutions. The Office of Saline Water is concerned not only with the desalting of sea water but also with the enhancement of the quality of brackish or saline water from any source. Therefore, the programs of OSW cannot be considered to be marine resource programs *per se.* However, OSW has earmarked certain of their projects which they feel should be included in the area of marine resources.

Of a total of 322 contracts active in 1968, 27 are considered to be related to marine resources.

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[12] *Ibid.*, October 1967.

These projects are not only desalting projects but include those concerned with the disposal of the effluent and its effects upon the marine environment and with the behavior (scaling and corrosion) of various materials in brackish or saline environments. The latter studies hopefully will lead to improved engineering capabilities in the field of desalting and in other marine science fields.

Approximately $2.5 million, or roughly 9 per cent of the total OSW budget in FY 1968, was earmarked for marine resource studies and about $2.7 million is earmarked in FY 1969. Projects are divided into two broad categories:

–Pure research ($820,000 in FY 1968). These are projects that are not applicable to any specific technological process but are aimed at increasing knowledge of desalting processes and enhancement of water quality. The greatest emphasis is on the corrosion of different materials and alloys.

–Development of new equipment and technology ($1,743,000 in FY 1968). The largest expenditure is in the field of corrosion of materials and the use of improved materials and alloys in the construction of equipment and tools. Also included in this category are projects concerned with brine disposal and the design of equipment to enhance the quality of desalted sea water.

OSW has underway an economic and feasibility study program involving state, municipal, and local groups as well as interagency and in-house team efforts related to the study of the practical application of desalting in real-life solutions. Cooperative studies are underway with New York State, New York City, New Jersey, Utah, and Texas. Work is underway to determine the potential application for desalting in the U.S. to help direct OSW's development program in terms of process needs, plant capacities, time-period of need, and related planning parameters. The latest desalting technology is being used in these studies.

VIII. PRESENT LEVEL OF PRIVATE SECTOR ACTIVITY

Many companies are conducting engineering studies on the various methods of desalting water, but the total amount being spent per year is not known. Most of the studies appear to relate to the refinement of the basic desalting processes that have been known for many years. Approximately half of the existing desalination plants are privately owned and privately financed.

FINDINGS AND RECOMMENDATIONS

Tidal power and power from thermal differences in the ocean are potential sources of power but present technology does not permit their use under favorable cost/benefit ratios. However, as energy requirements increase, National and local needs become more varied, and conventional sources become depleted, it is only prudent that these potential alternative sources of power be evaluated so that they can be developed expeditiously when the economic need arises.

Recommendation:

The Government should continue to consider and evaluate tidal power and power from thermal differences as possible alternative sources in planning ways to meet new power needs in some coastal areas.

I. PRESENT REQUIREMENTS

The Interdepartmental Energy Study, completed in 1964, shows that commercial per capita energy consumption in the United States as of 1961 was 180 million British Thermal Units, and total U.S. energy consumption in 1960 was 44,983 trillion BTU. The source pattern of total energy consumption in 1960 is given as follows:

Source	Trillion BTU	Per Cent of Total
Crude oil	17,172	38.2
Natural gas (dry)	12,736	28.3
Bituminous coal and lignite	9,967	22.2
Waterpower	1,775	3.9
Imported petroleum products	1,436	3.2
Natural gas (liquids)	1,427	3.2
Anthracite coal	447	1.0
Nuclear energy	23	.1

The Energy Study points out that the contemporary pattern is markedly different from that of a few decades ago when bituminous coal supplied two-thirds of all energy. A valid assumption is that the source pattern two or three decades hence will be markedly different from the present with nuclear power commanding a much stronger position.

Projections of U.S. requirements of energy consumption per capita, based on population, range from 300 to 337 million BTU for the year 1980, and from 350 to 438 million BTU for the year 2000. Total energy consumption projections range from 67.2 to 90.0 quadrillion BTU for 1980, and from 101 to 180 quadrillion BTU for 2000.[1] Conventional sources for this demand are those shown in the preceding table.

Potential sources of marine power include:

–Tides

–Thermal differences

–Ocean currents

–Waves

–Geothermal energy.

A. Tidal Power

The total tidal power dissipated by the earth is estimated at 1.4 billion kilowatts, of which 1.1 billion kw is accounted for by oceanic tidal friction in bays and estuaries around the world and can be captured and converted to electric power.[2] In spite of the huge potential, this energy source is scarcely utilized because practical development is very difficult. However, various possibilities have been and are being studied in geographic areas where the tidal behavior, range, and water displacement are most favorable.

The first large-scale development of tidal power is the Rance project in France where an investment of $100 million has been made. The Rance project features a single pool reservoir covering 8 square miles and a mean tidal range of about 26 feet. Power will be generated at an installed capacity of 320 megawatts and will provide 890 million kilowatt hours annually. Other projects involving much larger capacities are being studied by France and by the U.S.S.R.; England, Argentina, and Canada have sites with large potential.

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[1] Energy Study Group, *Energy Research and Development and National Progress*, prepared for the Interdepartmental Energy Study under the direction of Ali B. Cambel (1964), p. 333.

[2] *Ibid.*

The only practical opportunities for economic development of tidal power are in the vicinity of Passamaquoddy Bay, Maine and at some locations along the Alaskan coast. The capacity that might be installed has been estimated at 300 to 1,000 Mw.

The Passamaquoddy project has been carefully investigated and analysed as long ago as 1922 and again in the early 1960's. However, the latest report, published in 1965,[3] indicated an unfavorable benefit/cost ratio of .86 to 1. At current 1968 interest rates and costs the ratio is even lower.

Some of the problems include:

–Meshing the output generated during periods of high tide with periods of maximum needs, i.e. peaking power requirements.

–The average high tide is 18 feet but only 12 feet of this head can be used. Designing turbines to operate cheaply enough at low heads is still a problem.

–The dikes necessary to form a high pool are expensive in that they must extend 300 feet through unconsolidated material to hit bedrock.

–Political problems arise from the fact that Passamaquoddy would be a Federal development in a non-Federal, i.e. private utility area–and also its international location.

B. Thermal Differences

The possibility of generating power from temperature differences between tropical surface waters and cold waters from the ocean depths recently has been given serious consideration. This process, in effect, utilizes the sun's radiant energy with the ocean acting as the collector of that energy. It has been estimated[4] that the potential energy recoverable from thermal differences would provide a continuous source of energy 200 times as great as the projected world needs in the year 2000. However, methods to harness this source of energy have not been competitive because sea water itself was utilized as the working fluid in order to avoid the problem of transferring large quantities of heat into and out of the fluid at small temperature drops.

This is a high-cost operation because at the low temperatures inherent in a sea thermal plant steam volumes are so large that turbomachinery becomes excessively bulky and expensive.[5] Rusting of machinery and equipment is also a serious problem.

It has recently been suggested[6] that use of low cost noncorrosive propane as a power fluid (instead of sea water), and use of a floating power plant making short water lines possible, may make sea thermal power economically feasible.

C. Currents and Waves

Vast amounts of energy are contained in ocean currents and waves. However, studies indicate little possibility of developing power in commercial quantities from these sources except for ocean buoys to supply signals and light.[7]

D. Geothermal Energy

A type of energy whose potential is wholly unknown and cannot be evaluated is geothermal energy derived from thermal springs and subsurface steam reservoirs. Electric power is being generated from geothermal energy at the geysers in California, and a wholly unsuspected geothermal field was discovered near the Salton Sea a few years ago. These geothermal fields appear to be related to tectonically active belts and to areas of relatively recent volcanic activity. It is possible that such fields may be present in the continental shelves off the Pacific and Gulf Coasts.

II. PRESENT LEVEL OF GOVERNMENT ACTIVITY

The Department of the Interior is currently making studies on the feasibility of obtaining power economically from thermal differences

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[3] *Conservation of the Natural Resources of New England–The Passamaquoddy Tidal Power Project and Upper St. John River Hydroelectric Development, Report to President Lyndon B. Johnson* (1965), p. 5.

[4] John Isaacs and Walter R. Schmitt, "Resources from the Sea," *International Science and Technology*, June 1963, p. 44.

[5] J. Hilbert Anderson and James H. Anderson, Jr., "Power from the Sun by Way of the Sea?" *Power* (1965).

[6] *Ibid.*

[7] Conversation with Joseph Guidry, Department of the Interior, Oct. 4, 1967.

FINDINGS AND RECOMMENDATIONS

A. Introduction

Outdoor recreation is becoming a massive rush to the water. Even today, recreation ranks at least a close second to the offshore oil and gas industry in economic importance in marine areas. Shore areas provide the conventional recreation activities of swimming, fishing, and boating. Scuba diving and surfing have become major activities. Additionally, new technologies will make saturation diving in underwater manned habitats and the use of recreational submarines commonplace in future years.

Existing and future recreation uses of coastal areas raise major problems. These revolve around the difficulty of obtaining information on which to base policy decisions, of obtaining access to coastal areas for recreation purposes, and of managing recreation programs to achieve optimum benefits and safety.

B. Supply

Shoreline development for industrial, commercial, and a variety of other purposes is decreasing access to the shore while the demand for recreation is inexorably increasing. The Bureau of Outdoor Recreation estimates that there are 1,200 miles of shore frontage in the public domain reserved for recreation; future demand for 2,800 miles of frontage is forecast. There is no adequate information as to potential recreation resources from the private sector. In fact there is a general paucity of hard data on which to base policy decisions.

Existing publicly held properties are often distant from urban areas where the population is expanding most rapidly. The Department of Defense and other agencies have coastal facilities that could be opened to the public for recreational purposes, at least on weekends and holidays. The feasibility of creating new shoreline through excavation has not been explored.

Recommendation:

A definitive inventory of existing publicly and privately-owned public recreational facilities and of potential resources in coastal areas should be undertaken immediately to provide a basis for realistically appraising the needs for new resources. This should encompass a survey of publicly-held restricted shoreline areas to determine what areas could be opened to the public for recreational purposes, at least on weekends and holidays.

C. Obtaining Access

Existing publicly-held properties can never accommodate the pressures for marine recreation. Consequently, there must be emphasis on obtaining access to the shoreline, particularly near urban areas, through such devices as zoning, easements, use permits, and when necessary, through land acquisition. Regulatory devices and land acquisition should be guided by the uses contemplated in the comprehensive plans developed by the State coastal zone authorities.

Urban renewal and port development provide an opportunity to restore waterfronts accessible to urban residents for purposes of recreation. In planning new port facilities, for example, provision could be made for observational galleries and educational exhibits enabling the public to view dock-side operations. As the new transportation technologies render ports excess, some of them could be converted to facilities for coastal recreation.

One possible device to lessen the immediate outlay for land acquisition is to use discount bonds instead of the conventional interest-bearing bonds. The interest under the former arrangement is paid at maturity and a State or municipality could thereby defer raising the tax rate to finance interest payments.

Recommendation:

Federal, State, and local governments should give primary emphasis to acquiring access to the shores for purposes of recreation, especially near urban

populations. Steps short of acquisition should be used to the extent feasible but, when necessary to control coastal use, land should be acquired. Innovative financing arrangements should be pursued in view of the need to move promptly.

Recreation is a beneficial use of important natural resources which, if properly planned and managed, does not consume or degrade those resources. Recreation interests compete with other users, such as port developers and mineral explorers, and also there are conflicting demands among the various forms of recreation. Fishermen, swimmers, and power boaters are not always the best of neighbors. Therefore, access to the shore for recreation purposes needs to be supported by a management system that can assist to accommodate the interests of the various users. Such a system needs to bring together the three levels of government and private parties having an interest in coastal areas in order to focus on their common management problems.

Recommendation:

States establishing coastal zone authorities should take steps to assure adequate representation of the various recreation interests in the area.

The rapid growth of recreation is creating hazards in marine areas. Traditionally, there has been little regulation of recreation, of either equipment or operators. Even when there are laws on the books the States often lack adequate enforcement machinery. Legislation is pending that would authorize the Coast Guard to certify the safety of boats and equipment.

Added to the problems of maintaining safety standards for conventional recreation activities are the dangers involved in activities under the surface of the sea. Legislation is required to ensure the safety of operations in civilian submersibles that are used either for recreational or industrial purposes. This should be a responsibility of the Coast Guard.

Recommendation:

The Coast Guard should be provided the necessary legislative authorization to support safety requirements for recreation in coastal areas.

I. INTRODUCTION

A. Scope and Importance

Outdoor recreation increasingly is becoming a massive rush to the water, as the President's Outdoor Recreation Resources Review Commission (ORRRC) found in its comprehensive report issued in 1962. Nearly everyone wants to get in or on the water. Marine recreation, including activities on the seashore and in the adjoining water, has become big business and is certain to grow rapidly in the future. Therefore, preservation and development of seashore lands for recreational purposes are matters of National interest and concern.

The practical problems of preserving coastal lands and managing recreation activities along the water appear staggering, especially in populous areas. However, the studies of the New York and San Francisco metropolitan areas have demonstrated that practical solutions, short and long range, are indeed within reach, given an adequate amount of ingenuity and experimentation. What is missing is money, authority, and public understanding.

In this report no attempt will be made to compete with the monumental and definitive ORRRC report in detailed proposals for practical solutions. The purpose of this report is to present a broad and relatively brief review of the general nature and dimensions of the problem of marine recreation and the general direction of solutions. Attention will be directed chiefly to the coastal zone, a relatively narrow strip of land and water where the recreational resource base is centered. However, additional resources such as underwater wilderness areas that may be located 12 or more miles offshore also offer recreational opportunities and must be identified and preserved.

If marine recreation, in all its forms and ramifications, can be called an industry it presently ranks at least a close second to the offshore oil and gas industry in economic importance. It may, in fact, actually outrank oil and gas, but statistics are inadequate to segregate recreational expenditures in the marine environment from those on land.

It is sometimes asserted that recreation is not subject to economic analysis and that its value is purely social and personal. A corollary assertion is that any recreation development is good and that there is no need to measure economic values.

Neither statement is helpful in making choices among individual opportunities. It is necessary to know and to be able to compare the net values that would be added by various alternatives if the greatest social benefit is to be obtained from an investment.

Clawson and Knetsch,[1] in an excellent discourse on the economics of outdoor recreation, argue that recreation has economic value to the extent that people express a willingness to pay for the opportunity to engage in recreation activities. They show that demand for the whole recreation experience can be estimated from data on numbers of visitors correlated with costs of visitation by distance zones; and, further, that a demand curve for each recreation resource or area can be derived from the demand curve for the whole experience. The total area under each specific demand curve is the sum of the various units of output from the area or project, and this measures the total *economic worth to society of the recreation* services provided by this area or resource. The technique developed by Clawson and Knetsch is a valuable contribution but, as they point out, far more data are needed if precise results are to be obtained.

Swimming, boating, hunting, and fishing are the traditional recreational activities of the coastal areas. In recent years a number of new activities–surfing, water-skiing, scuba diving, and snorkling–have become extremely popular and have generated greater interest in the submarine environment of the coastal waters. Other activities which are enjoyed and vigorously pursued in coastal areas where opportunities are available include beachcombing, bird watching, hiking, bicycling, picnicking, camping, nature study, photography, painting, and general sightseeing. A comparative summary of the economic importance of some important recreational activities in coastal and offshore areas is given in Table 1.

B. Conflicts

Recreation is a beneficial use of important natural resources which, if properly planned and managed, does not consume or degrade those resources. Recreation interests compete with other users, such as commercial fishermen, port and harbor developers, and mineral extractors, whose interest in exploiting the shoreline is certainly legitimate.

There is competition for waterfront use by commercial and shipping interests and industrial plants. Farther out from the central cities the main competitors for shoreline space are private residen-

Table 1
A COMPARATIVE SUMMARY OF ECONOMIC ACTIVITY[1]
In Coastal and Offshore Areas

Type of Recreation	Participants, Millions 1964	Participants, Millions 1975	Annual Expenditures Millions of dollars 1964	Annual Expenditures Millions of dollars 1975
Swimming	33.0	40.0	$1,500	$2,000
Surfing	1.0	4.0	50	200
Skin diving	1.0	3.0	300	900
Pleasure boating	9.6	14.0	650	1,000
Sport fishing	8.2	16.0	760	1,300
National park and forest recreation	18.4	44.0	600	1,390
Total	71.2	121.0	$3,860	$6,790

Source: Development Potential of U.S. Continental Shelves, U.S. Department of Commerce, 1966.

[1] Economic activity refers to and includes multiple types of dollar sources such as operating expenditures, investments, and income.

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[1] Marion Clawson and Jack L. Knetsch, "Economics of Outdoor Recreation" (Baltimore: Johns Hopkins Press, 1966).

tial developments and, in limited areas, industry. Large stretches of shoreline have been preempted for governmental use by the military and for highway and other transportation uses. The preservation of shoreline for wildlife refuges precludes use of some sites for mass recreation purposes.

A recent survey by the Fish and Wildlife Service on conflicts between sport and commercial fishermen reports:

> *Too often conflict issues are permitted to reach emotional heights where scientific evidence is ignored and reason and compromise are pushed aside. Then, misdirected public opinion and organized vested interests take over to influence expedient political actions that can only lead to more bitterness and hostility.*

Extraction of mineral and fuel resources, which commonly requires the erection of aesthetically undesirable structures, and which may result in pollution of the waters, is often incompatible with recreational use of the marine environment. Yet it is in the public interest to exploit these mineral and fuel resources, provided we can devise ways to manage their exploitation without damages to other users that exceed the net benefits obtained.

There are also conflicting demands among the recreation seekers; fishermen, swimmers, surfers, power boaters, and water skiers are not always the best of neighbors. Moreover, increasing public access through highway construction to naturally primitive scenic areas detracts from the wild and isolated nature of the sites, raising conflicts with naturalists and bird watchers.

Water quality is as important to marine recreation as the amount of surface, miles of shoreline, or location. Polluted water seriously restricts recreational use and esthetic values and reduces fish and wildlife populations.

Pollution by human or industrial waste is only one aspect of the problem. The silt load, temperature, and nuisance aquatic plants also affect the usability of water for recreation. As water becomes more polluted, recreational uses are more restricted. Contact activities such as swimming, skindiving, and skiing are foreclosed; even boating opportunities are shunned.

Although the highway building program of the last decade has provided generally better access to marine recreational areas, serious problems remain. There is frequently inadequate parking space at marine facilities. Mass transportation is not available in most cases. And having arrived at a beach, what right does a person have to be there? Is walking on beach land in the category of trespassing where property above the high-water mark is privately owned? Should public easements be acquired for such uses? Local governments have been unwilling or unable to cope with this problem. Certain States have enacted legislation to define these rights, but greater attention to this problem by all coastal States and municipalities is urgently needed.

Allocation of coastal area resources between recreation and other uses will require the soundest planning and the most positive action that can be brought to bear. But it is necessary to define precisely what we wish to accomplish.

II. DEMAND

The demand for marine-oriented recreation opportunities will continue to grow more rapidly than the population. The move toward salt waters and large fresh water bodies, such as the Great Lakes, will result from these factors: the increasingly crowded conditions under which people live and play on land, which will cause many to look to less crowded conditions for recreation; rising personal income coupled with increased leisure time and mobility; and the rapid growth of recreational technology which will introduce new forms of marine sports and opportunities.

Demographers estimate that the U.S. population will approximately double by the year 2000, and 175 million people will be living in the coastal zone, including the Great Lakes. The ORRRC found, moreover, that increases in the demand for many types of outdoor recreation far outstrips population increases. For example, between 1950 and 1965, while the population was increasing from 152 million to 194 million (29 per cent), the number of fishing licenses increased from 15.3 million to 24.9 million, (63 per cent) and the number of outboard motors in use more than tripled, rising from 2 million to 6.7 million during this period.

The Bureau of Sport Fisheries and Wildlife estimates that at present there are 8.3 million salt water sport fishermen. In 1965, these anglers fished about 97 million man days and spent an estimated $800 million on the sport. If present trends continue, salt water angling will represent about one-third of the total National sport fishery effort by 2000.

Indications of demand for marine recreation are based on a concept of "occasions of participation" in summer outdoor recreation activities. The overall predicted demand for recreational occasions in the coastal zone by the year 2000 is 4.5 billion. For some specific marine-related activities, the figures in Table 2 are relevant.

Table 2
OCCASIONS OF PARTICIPATION IN OUTDOOR RECREATION
(in millions)

			Projections		Per Cent Increase
	1960	1965	1980	2000	1965-2000
Swimming . .	672	970	1,671	2,982	207
Fishing . . .	260	322	422	574	78
Boating . . .	159	220	386	694	215
Water skiing . .	39	56	121	259	363

Source: Bureau of Outdoor Recreation.

The increased demand for public marine recreation areas has led to grave problems of overcrowding at the beaches, in the water, and near the shores. Traffic tie-ups are common on highways leading to and from the beaches every summer weekend. The coves, harbors, and bays are becoming so crowded with sail and motor boats that health and safety hazards have become serious.

Rising income has made more money available for expenditure on recreation. Per capita disposable income rose from $1,346 in 1950 to $2,567 in 1966. Total personal consumption expenditures rose from $11.1 billion in 1950 to $26.3 billion in 1966, although the *percentage* of personal income spent for recreation rose only from 5.8 per cent to 6.1 per cent during the same period.

Further increasing the demand for marine recreation are longer vacations, shorter work weeks, and better access to the seashore provided by the highway building program of the past decade.

The method used to allocate outdoor recreation resources determines in large part the identity of the participants. If outdoor recreation deserves public support, whom should be provided with opportunities?

At present public outdoor recreation benefits accrue mainly to the upper half of the income strata. The poor are in greatest need and are also least able to purchase these benefits. If the Nation is serious about the public values of outdoor recreation and if it is agreed that the lower income people from metropolitan areas need such benefits, more must be done.

A most critical problem is that of preserving natural playgrounds near population centers. President Johnson emphasized the point in a speech on June 29, 1968 when he said that the United States must concentrate on preserving recreation areas near cities. Too many Americans cannot afford to visit the great National parks in the West, he said. "We can no longer go in search of far horizons while we neglect the land under our feet," Mr. Johnson declared, "Our new conservation must build on a new principal: Bringing nature closer to people."

The President's statement bears strongly on marine recreation because such a high percentage of our great cities are in the coastal areas. Projections indicate that by 2000, the residents of metropolitan areas will more than double in number and comprise about 73 per cent of the U.S. population. About three-quarters of the increase will be along the shorelines of the Atlantic and Pacific Coasts and the Great Lakes in the "megalopolitan" areas of Boston-Washington, San Diego-San Francisco, and Milwaukee-Cleveland.

A major finding of the ORRRC report also was that the most urgent need for recreation opportunities is not in far-away places, but in the *50 mile "day-trip" zone* close to major urban areas. Thus the most ***heavily impacted*** area of marine recreation (and in fact of all outdoor recreation) is within about 50 miles of the big cities. This is not to say that there is no urgency elsewhere. There are many problems beyond 50 miles. But the greatest need is for high-cost, high-density facilities on a tiny proportion of the acreage to handle huge masses of people conveniently while the surroundingland, thus protected, provides untroubled amenity. Such high-density facilities might include opportunities for swimming, surfing, skin diving, fishing, picnicking, playing outdoor sports, and observing marine life from fixed or mobile underwater observatories.

Programs aimed at waterfront redevelopment in urban areas can provide for high-density recreational facilities as well as for other needs. Not only should consideration be given to the development of suitable stretches of shoreline for recreation, but in planning new port facilities; for example, observational galleries, dock-side restaurants, and educational exhibits could be provided, along with adequate access and parking space, to enable the public to view dock-side operations.

The drama of docking and loading and unloading ships has a special fascination for both local audiences and tourists, yet few opportunities are available to view such operations at close range.

A second kind of need is for marine recreational areas in the *"week-end* and *vacation"* zones, which might extend from 50 to several hundred miles from home. Such areas will generally be much more spacious than the high-density "day trip" areas and would include additional recreational opportunities, such as camping, sailing, power boating, water skiing, deep sea fishing, hiking, photography, bird watching, staying in an underwater habitat, and general sightseeing. Access would be mainly by automobile, and the need for public transportation less urgent than in the case of the "day-trip" zone. Most areas of this type would come under the jurisdiction of State and Federal Governments, although the distinction is not clear-cut.

A third kind of need is for marine wilderness preserves. Our coasts contain a number of unique scenic areas and marine ecological communities, but these are decreasing. The habitats of certain endangered species of fish and wildlife are among the dwindling sites. The Arkansas Wildlife Refuge on the Texas coast in which whooping cranes spend their winters is perhaps the most famous of such areas. Specialized habitats such as these, as well as underwater wilderness areas, must be included in a balanced National outdoor recreation system.

III. SUPPLY

A. Existing Coastal Recreation Areas

More than 400 recreation areas in the coastal zone have been developed by Federal and State government agencies. The capacity of these areas is unknown.

Twenty of the larger areas, administered by the National Park Service, are listed. Most are well beyond the reach of the day-trip zone and the disadvantaged citizens of urban areas.

Atlantic Coast

Acadia National Park, Maine
Cape Cod National Seashore, Massachusetts
Fire Island National Seashore, New York
Assateague Island National Seashore, Maryland-Virginia
Cape Hatteras National Seashore, North Carolina
Cape Lookout National Seashore, North Carolina
Everglades National Park, Florida
Fort Jefferson National Monument, Florida

Caribbean

Virgin Islands National Park, Virgin Islands
Buck Island Reef National Monument, Virgin Islands

Gulf Coast

Padre Island National Seashore, Texas

Pacific Coast

Channel Islands National Monument, California
Point Reyes National Seashore, California
Olympic National Park, Washington
Glacier Bay National Monument, Alaska
Katmai National Monument, Alaska
Hawaii Volcanoes National Park, Hawaii

Great Lakes

Isle Royale National Park, Michigan
Pictured Rocks National Lake Shore, Michigan
Indiana Dunes National Lake Shore, Indiana

Local governments and private enterprise have also developed numerous areas and facilities, although the number and capacity are unknown. Nor is information available on whether the capacity of any of these areas can be expanded to accommodate additional use.

The unknown capacity factor makes it difficult or impossible to assess the adequacy or inadequacy of existing and potential facilities in terms of present and future demand for shoreline recreational space.

A definitive inventory of the Nation's coastal recreational resources, including existing and potential resources, is required to provide the facts for sound planning. The size and optimum capacity of recreational areas and the types of facilities available need to be identified and compared with current and projected demands for marine-oriented recreation in individual areas or regions. An agency of the Federal Government (Bureau of Outdoor Recreation) could conduct the survey with cooperation from State and municipal governments and private organizations.

Recommendation:

A definitive inventory of existing publicly and privately-owned public recreational facilities and of potential resources in coastal areas should be undertaken immediately to provide a basis for realistically appraising the needs for new resources.

B. Potential Coastal Recreational Areas

The 48 contiguous States have about 59,000 miles of shoreline out of which 21,724 miles was classified by ORRRC as having recreation potential. Some 4,350 miles are beach, 11,160 miles are characterized as bluff, of which perhaps half has usable beach, and 6,214 miles are marsh shoreline.

How many people could be accommodated by this much shoreline? Research data relevant to this problem are virtually nil.

However, a number of city and county planning commissions have standards which call for 75 to 150 square feet of beach per person. If one assumes an average beach width above water of 50 feet and applies the criterion of 150 square feet per person as ORRRC did, each mile of beach could accommodate 1,760 persons, and on this basis the existing beach extent of 4,350 miles could accommodate 7,656,000 persons. Assuming that 10 per cent of the population will use the beach at a given time the existing beach shoreline of the United States could accommodate a population of about 77 million.

If the comparably derived figure applicable to the half of the 11,160 miles of bluff shoreline that has beach areas is added, an additional 112 million persons could be served, making a total of some 200 million. The potential of marsh shoreline to accommodate people is not known but it could be large.

Thus, if only gross area is considered, there is not at present a shortage of shoreline for recreation purposes. However there is a problem of ownership and, more importantly, a problem of *imbalance* between the location of population centers and accessibility to adequately developed shoreline open to the use of the general public.

Of the total 21,724 miles classed as recreational shoreline 19,934 miles,[2] or 92 per cent, was privately owned in 1962, and although a substantial number of recreation facilities, such as resort hotels and marinas, have been developed by private industry, the recreation activity absorbed by the private sector is not known. Certainly the overwhelming bulk of privately held land is preempted for vital *non*-recreational purposes. However, some privately-held lands could probably be used for public recreation if demand were great enough to make it economically feasible, or, alternatively, if Government incentives could be provided.

Of the 1,790 miles (8 per cent) in public ownership in 1962, 581 miles is in military or other restricted usage, leaving only 1,209 miles or a little more than 5 per cent of the total recreational shoreline for publicly-owned recreational areas. Applying the criterion of 150 square feet per person over a 50-foot wide strip of shoreline as ORRRC did gives recreational accommodations for only about 2.1 million persons, enough to serve a population of only 21 million, by ORRRC's rule of thumb. This assumes that all of the 1,209 miles is beach shoreline, which it is not.

The above exercise indicates that if allotment of 150 square feet per person is valid, there is indeed a shortage of *publicly owned* recreation shoreline, which is doubtless even more serious than it appears if one takes into account that only a small fraction of the 1,209 miles is readily accessible to urban areas where the greatest need lies.

What can be done to improve this situation which can only become worse as recreational demand rises?

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[2] An unknown amount of this shoreline has been acquired for parks, etc. since 1962.

Apart from acquisition of more land, which will be discussed elsewhere, it appears that a number of other actions should be taken.

First, apparently little or no research has been done on just how many people can be comfortably accommodated on a mile of beach. Is the figure of 150 square feet per person adopted by various local planning commissions and ORRRC realistic? However difficult is may be to obtain, sound information of this type is essential if realistic planning is to be accomplished.

Second, much of the 581 miles of publicly-held shoreline with recreation potential presently under military or other restricted usage is within fairly close proximity to urban areas. It would add a most useful increment to the supply of recreational areas if it could be opened to the public at least on weekends.

Recommendation:

A survey should be made of publicly-held restricted shoreline areas to determine what areas could be opened to the public for recreational purposes, at least on weekends and holidays. Special attention should be given those areas near urban centers. The Bureau of Outdoor Recreation, working in cooperation with the military or other groups controlling the coastal area involved, should have responsibility for making the survey. Steps should then be taken to open whatever areas are found to be available to the public.

In many areas it may be possible to increase the amount of shoreline substantially by excavation. Such a procedure could appreciably enhance the value of high-density play areas near urban centers.

Recommendation:

In places where it is physically feasible and where a real need exists, new shoreline should be created by excavation. Excavating might in many cases be integrated with various public and private dredging and filling operations conducted for other purposes.

Apart from the shorelines required for general recreational purposes, there is need to preserve areas of outstanding, representative, or unique scientific, cultural, or aesthetic interest. Although the supply is no doubt ample, such underwater wilderness areas or sanctuaries have not yet been identified or defined.

More than any other, these types of resource use require early reservation, and decisions to commit the areas to competing purposes are irreversible. It is therefore essential to define and set aside such areas well in advance of actual need. These areas will also need to be identified by careful surveys and their preservation and development planned in the context of the overall development and exploitation of our marine resources.

IV. GOVERNMENT PROGRAMS

A. Federal

During the past few years the whole field of outdoor recreation has been significantly strengthened and given top-level recognition at the Federal level of government. The recommendations of the ORRRC led to Government actions and programs designed to:

–Accelerate the preservation of open space

–Formulate National policies emphasizing that recreation should be more people-oriented, especially in urban areas

–Promote greater action by State and local governments

–Foster better coordination among Federal agencies with recreational interests.

Discussion of specific actions and programs follows.

1. Land and Water Conservation Fund

One of the most important programs resulting from the ORRRC recommendations was the Land and Water Conservation Fund authorized by Congress in 1964. This fund, administered by the Bureau of Outdoor Recreation, is designed to provide financial assistance to local, State, and Federal agencies in planning, acquiring, and developing recreational projects.

Sixty per cent of the fund's resources are available to the States on a 50-50 matching basis, and 40 per cent goes to National Park Service, Bureau of Sport Fisheries and Wildlife, and the Forest Service. The Federal portion is used for land acquisition, to help preserve rare and endangered species of wildlife, and to offset portions of the capital costs allotted to public recreation and enhancement of fish and wildlife values at Federal water development projects authorized after Jan. 1, 1965.

Source of the funds is from entrance and user fees at Federal areas, net revenues from sale of Federal surplus property, and the proceeds from existing Federal tax on motorboat fuel. Because the fund is still not providing adequate financial assistance, authorization has been obtained to use Outer Continental Shelf oil and mineral leasing revenues as additional sources of revenue.

Since the Land and Water Conservation Fund program went into effect in January 1965, total funds allocated have amounted to $352,312,239, of which $131,152,431 has been for Federal programs, $214,314,808 for State programs, and $6,845,000 for administrative expense. During Fiscal Year 1968, Congress appropriated $51,416,000 for Federal acquisitions, $65 million for State acquisitions and development grants, and $2,775,000 for administrative expense.

Since the inception of the program, 133 State projects totaling $28,150,000 have been undertaken, involving acquisition and development of recreation areas along the coastlines and Great Lakes. Almost all the States have adopted a policy of sharing their annual allocation with local governments. The effectiveness of the fund is difficult to evaluate because of its short period of operation; its full impact will not become apparent for another 5 to 10 years.

2. President's Council on Recreation and Natural Beauty

A Presidential Executive Order, dated May 4, 1966, established the President's Council on Recreation and Natural Beauty. This council is the successor to the Recreation Advisory Council created several years ago. The council includes the Secretaries of Agriculture, Commerce, Defense, Interior, Housing and Urban Development, and Health, Education and Welfare; the Chairman of the Federal Power Commission; the Chairman of the Board of Directors of TVA; and the Administrator of the General Services Administration. The Director of the Bureau of Outdoor Recreation serves as Executive Director of the Council.

The Executive Order creating the Council also provided for a Citizens Advisory Committee, which includes 11 members appointed by the President.

Both the Council and the Committee have been directed to focus attention on a wide range of needs and problems related to the provision of recreation opportunities and the enhancement of the quality of our environment. Their findings and recommendations in their report, "From Sea to Shining Sea," should have a major impact on Federal policy and programs.

3. Department of the Interior

The major Federal effort in outdoor recreation in the marine environment is centered in the Department of the Interior, whose program has been expanded as a result of the ORRRC recommendations. The National Park Service and the Bureau of Sports Fisheries and Wildlife have the specific mission of acquiring and managing marine resources for conservation and recreation purposes. The Bureau of Outdoor Recreation was established in 1962 in response to a recommendation of the ORRRC report to serve as the principal recreation coordinating and extension agency of Government and to manage the Land and Water Conservation Fund.

The 20 marine parks administered by the National Park Service are dedicated primarily to water-oriented recreation and to the preservation of scenery and natural resources. About seven million visits were made to these areas in 1966. The sum of $18.5 million was appropriated in fiscal year 1967 for the management, protection, maintenance, development, and land acquisition of 18 of the above areas. Interior's program proposed the acquisition and development of additional marine areas which will require future appropriations estimated at $208.5 million.

During the period 1954-1959 the National Park Service conducted shoreline studies which have been of value in identifying the recreation resource potentials of the coastlines. A total of 194 areas covering 1,593 miles of coastline were identified by these studies. Partly as a result of these studies the 20 National marine parks have been authorized by Congress, and additional parks are proposed.

Many States likewise have acquired coastal lands for recreation uses, with the result that the Nation's overall marine recreation capacity has expanded greatly in recent years.

Shoreline studies by the Park Service have also been made in the Hawaiian Islands, Guam, American Samoa, the Virgin Islands, and Puerto Rico. Discussions are also underway regarding future marine park and recreation studies in the Pacific Trust Territories.

The Park Service is presently planning a program to implement the desires and needs of visitors for underwater observation and interpretation in marine parks. Such innovations as self-guiding underwater nature trails are now in the experimental stage, and studies relating to submersible habitats for camping and visitor observation of sea life in natural parks are being pursued by the Park Service and the American Institute for Research.

The Bureau of Sports Fisheries and Wildlife administers the National system of wildlife refuges, of which 82 are located on the coasts of 19 States and the Virgin Islands. They have a total shoreline of about 500 miles and encompass a total area of more than 18.3 million acres, of which 7 million acres are estuarine. About 1.3 million visits were made to these refuges in 1966. The refuges provide important breeding, feeding, and wintering grounds for waterfowl, other migratory birds, and endangered species, as well as recreation opportunities and facilities.

4. Other Federal Agencies

Several other Government agencies have programs and responsibilities that relate directly to or at least impinge on outdoor recreation.

In addition to Interior's programs, the Department of Housing and Urban Development provides financial aid to local governments for open space preservation and city parks. The missions of these two departments are quite extensive, and their programs of technical assistance, planning, and dissemination of information are important contributions to the total marine recreation effort.

There are restricted National defense areas with marine recreation potential and a few National

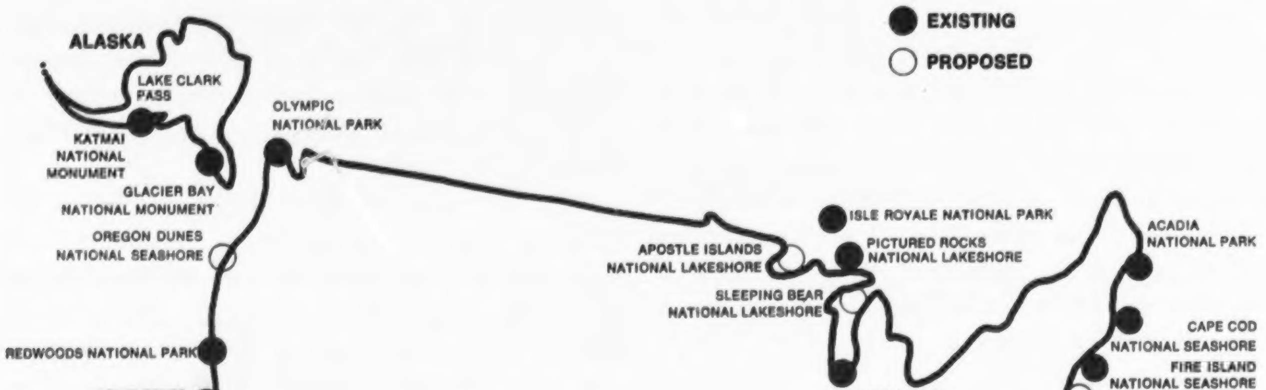
● EXISTING
○ PROPOSED
ALASKA
LAKE CLARK PASS
KATMAI NATIONAL MONUMENT
GLACIER BAY NATIONAL MONUMENT
OLYMPIC NATIONAL PARK
OREGON DUNES NATIONAL SEASHORE
REDWOODS NATIONAL PARK
POINT REYES NATIONAL SEASHORE
CHANNEL ISLANDS NATIONAL MONUMENT
ISLE ROYALE NATIONAL PARK
APOSTLE ISLANDS NATIONAL LAKESHORE
PICTURED ROCKS NATIONAL LAKESHORE
SLEEPING BEAR NATIONAL LAKESHORE
INDIANA DUNES NATIONAL LAKESHORE
ACADIA NATIONAL PARK
CAPE COD NATIONAL SEASHORE
FIRE ISLAND NATIONAL SEASHORE
SANDY HOOK NATIONAL SEASHORE
ASSATEAGUE ISLAND NATIONAL SEASHORE
CAPE HATTERAS NATIONAL SEASHORE
CAPE LOOKOUT NATIONAL SEASHORE
CUMBERLAND ISLANDS NATIONAL SEASHORE
CANAVERAL NATIONAL SEASHORE
BISCAYNE NATIONAL MONUMENT
VIRGIN ISLANDS NATIONAL PARK
BUCK ISLAND REEF NATIONAL MONUMENT
PUERTO RICO & VI
EVERGLADES NATIONAL PARK
FORT JEFFERSON NATIONAL MONUMENT
GULF ISLANDS NATIONAL SEASHORE
PADRE ISLAND NATIONAL SEASHORE
KAUAI NATIONAL PARK
HAWAII
HAWAII VOLCANOES NATIONAL PARK
NOT SHOWN: GUAM NATIONAL SEASHORE ○
SAMOA NATIONAL SEASHORE ○

Figure 1. *Marine parks in the National Park system. Source: National Park Service, Department of the Interior.*

Forests close to or bordering the coastal waters and Great Lakes which are now partly used for recreation, but neither the Defense nor the Agriculture Departments manage these areas specifically as marine parks or with the idea of providing extensive opportunities for marine recreation. Nevertheless, these coastal lands are important in conserving outstanding scenic and recreation resources, and the Defense Department has conservation officers attached to base installations. Recreation is part of the multiple-use concept for the management of all National Forests, several of which border the coasts. In recent years the role of recreation in National Forest management has been strengthened and will continue to expand.

Other Federal Government agencies, including the Corps of Engineers, Soil Conservation Service, Coast Guard, and Environmental Science Services Administration perform services that support recreation operations.

B. State

State government organization for marine recreation activity typically divides jurisdiction among a number of agencies. Park, conservation, and fish and game departments are most common. The agency having responsibility for State park systems usually has the bulk of marine recreation functions.

State departments of conservation and natural resources generally have non-park beach and shoreline preservation functions. They plan and operate wildlife refuges, preserve wetlands, control filling and dredging in some cases, and may be responsible for State water resource functions.

The position of park systems in governmental structure of States is varied. It may be summarized as follows:

–In 14 States, parks are a subdivision of a major department with a single executive head. This system tends to cluster recreation and related activities under an executive who has a broad view of problems and can move toward integrated solutions within his own department.

–In 10 States, parks are in major departments headed by boards or commissions. Members of these bodies are either *ex officio* or are appointed by the Governor and range in number from 3 to 13. Commissions are ordinarily thought to be less effective administrative devices than individual executives responsible to the Governor.

–In five States parks are administered by separate agencies directly headed by boards or commissions.

–One State has a separate Department of State Parks with a single executive head responsible to the Governor.

–In at least four States administrative supervision of State parks is decentralized. Local groups or commissions supervise regional or individual parks in two of the four, while in a third State each park is a separate administrative division. The fourth State is divided into four geographical sections, each with a separate administrative division.

It appears that governmental structure in quite a number of coastal States is too diffuse and uncoordinated to cope adequately with the need for planning and developing marine recreation areas. Better internal coordination of the activities of various State agencies might make for more efficient planning and development of marine resources.

Although most of the coastal States have incorporated shoreline parks into their State park systems the efforts are spotty, and it appears that many State parks departments pay relatively little attention to marine recreation, as evidenced not only by the small amount of beach area that has been preserved for public beaches, but by the apparent nonavailability of even basic information on marine recreation facilities in State offices responsible for administering such facilities.

Each State has an outdoor recreation plan, prepared largely to comply with the grant eligibility requirements of the Land and Water Conservation Fund Act, but there is in most cases little continuous planning for marine recreation. Furthermore, many of the State recreation plans are not the products of State planning agencies but are the results of contracts let with private consulting firms. Interviews with State officials lead to the conclusion that plans are not being vigorously implemented and will not be until marine recreation planning is more closely related to operational agencies. In general, marine recreation appears not to have a high priority with State planning officials.

During the last 10 years, bond issues for park and recreation area acquisition and development have done much to strengthen the role of some States in assuming a greater share of the leadership and responsibility for recreation at the State and local levels.

The Pacific Coast States have probably acquired the most public areas along their coasts since 1965 when the Land and Water Conservation Fund Act was passed by Congress. In 1965, the Oregon legislature designated the entire State-owned shoreline between high and low tide public property as a state recreation area and in 1967 the State of Washington established a seashore conservation area along its entire coastline from Canada to Oregon. California's legislature recently established a State Advisory Commission on Marine and Coastal Resources and requested it to develop a master plan for the entire California coastline and prepare a report by 1969.

Some States along the eastern coastline and Great Lakes have made notable strides in providing marine recreation areas within the last few years.

–Florida established the first submarine park in the country and is preparing plans for a system of marine preserves.

–Michigan made additional studies of its lakeshore in 1967 and is expected to issue a report shortly.

–Wisconsin recently established shoreline zoning.

–The Maine legislature passed a wetland preservation act and a $4 million bond issue for park land acquisition, with particular emphasis on a system of shore parks and island reserves.

–Massachusetts and Connecticut are both moving toward greater shoreline acquisition and preservation with new financial and planning programs.

A few States in the Southeast are still not moving rapidly enough in acquiring shoreline. This is unfortunate because some of the finest seashores in the country as well as favorable climatic conditions for year-round recreation use are along the southeastern U.S. coasts.

In selecting areas for acquisition the States operate much like the Federal Government in that their primary targets are shoreline areas of high quality that are of interest to all the people of the State.

Most States seem to have only a limited view of the recreation needs of the poor. The disadvantaged somehow do not become a part of the political arena in which recreation demands are made. Emphasis on boating, for example, is meaningless to the poor, who cannot afford boats and who at best tend to be crowded into central city beaches.

Disadvantaged economic groups are often unable to use existing facilities because they do not own automobiles and because public transit facilities to marine recreation areas are unavailable. With the exception of in-city mass transit facilities, such as the subways to Coney Island and the Rockaways in New York there is inadequate public transportation to most State parks or National seashores.

Recommendation:

In order that disadvantaged groups can have a means of enjoying recreational opportunities, provision should be made for transportation of the poor, through poverty funds, from metropolitan areas to nearby marine recreation spots.

C. Interstate Agencies

With the exception of the Palisades Interstate Park Commission in New York and New Jersey, whose jurisdiction is essentially the Hudson River, no interstate agencies conduct significant marine recreation activities. The Delaware River Basin Commission will coordinate development of the Delaware Water Gap National Recreation Area in Pennsylvania and New Jersey, near Tocks Island, but this is primarily an upriver project.

Interstate agencies could play a much larger role than they do, if only because marine recreationers tend to be mobile and create problems which often transcend State boundaries. Even in the absence of interstate agencies there are opportunities for close cooperation between States in developing recreation resources. The resources of one State may only be efficiently utilized by attracting users from an adjacent State. The Commission commends joint planning by States as a means for broadening the recreation opportunities for citizens whose States lack adequate coastal facilities.

D. Local

Historically, local governments were the first to concern themselves with providing outdoor recreation facilities, and it is at the local level that the greatest activity takes place with respect to marine recreation.

Municipalities not only operate seaside parks and beaches but also run docks and marinas and provide a wide range of marine recreational facilities. By far the largest number of parks are still run by local governments. Attendance figures for local parks and beaches are for the most part rough estimates, but it can be safely assumed that local parks and beaches provide recreation opportunities for more people than the National and State systems.

Although the Commission has relatively little systematic information about local park systems available, field visits conveyed the impression of high quality work, professionalism, ambition, planning expertise, and political acceptance of the local park systems in such coastal cities as Milwaukee, Chicago, San Diego, and Santa Monica. But not all local systems are as impressive. Many local governments deserve praise for the foresight, energy, and expenditures they have made to provide facilities for their citizens. A positive sign is the increase in the number of municipal bathing beaches from 951 in 1960 to 1,261 in 1965.

But there are two serious adverse factors. First, in some cities, such as Chicago, New York, and Milwaukee, virtually all shoreline usable for recreation already is park property and is insufficient for projected demand. Second, a growing tendency by counties and municipalities adjoining large urban areas to restrict their local parks to use by local residents threatens to surround major concentrations of population with recreation facilities they are forbidden to use. This latter development particularly discriminates against low-income groups and racial minorities.

However, when State or Federal funds are used by counties and municipalities for acquisition, development, or operation of facilities, such local residency restrictions are prohibited. Land and Water Conservation Funds are available to local governments from their State's allocation. The local projects for which funds are requested must fit within the framework of State objectives outlined in the approved overall State recreation plan.

A Bureau of Outdoor Recreation survey of expenditures in 45 of the 50 States shows State agencies spent an average of $150 million and local public agencies in those same States an average of $280 million on outdoor recreation capital improvements in each of the three years before the passage of the Land and Water Conservation Fund Act. Since its passage, capital expenditures for recreation have averaged $291 million (State) and $335 million (local) each year.

These overall amounts, which do not identify marine recreation expenditures, seem to be in approximately the right relative proportion. However, serious divergences occur in some areas. For example, during the three-year period 1965-1967 a total of $9,050,220 of Land and Water Conservation Fund monies were requested for marine recreation projects by nine States in the densely populated northeast segment of the United States. But only $78,218 went to local governments. Why such a trivial sum was spent on local projects is not certainly known, but it may be partly because local governments were not sufficiently ready to utilize the funds in the first years of the program and partly because States were reluctant to pass the funds on to local governments. On the other hand, it may be that the Land and Water Conservation Fund requirement not to be restrictive in use of lands acquired and developed with its monies discourages local governments from participating in the fund.

V. PRIVATE ENTERPRISE

A very important role in marine outdoor recreation not always recognized, is played by private enterprise. The enormous private investments in such coastal resort cities as Miami Beach and Atlantic City, and their numerous but smaller counterparts along our coastline, provide services and facilities to people seeking a variety of outdoor recreation experience ranging from big-game fishing to lounging on the patio of a luxury hotel with seascape as background.

Vast numbers of marinas, boat rentals, artificial reefs, fishing piers, charter boats, beaches, private swimming clubs, hunting clubs, and preserves provided by private entrepreneurs also help greatly to accommodate the demand for marine-oriented recreation. In addition, restaurants, sporting equipment shops, motels, parking areas, and other essentials and amenities are furnished by private enterprise. Industry also develops new kinds of recreational gear and equipment for recreational use, and designs, engineers, and builds facilities on public recreational lands.

Private enterprise may also, through trade associations, help provide statistical information for both public and private planners, and through advertising, help "sell" the marine environment as a place for recreation.

Important and complex questions that arise include:

–What are the relationships among the public and private purveyors of coastal recreation and are they such that they complement one another?

–What can the public sector do to stimulate the private sector to meet unsatisfied demands?

–How can quality, such as harmony and aesthetics, be uniformly maintained in the private section?

The panel has no special information or expertise to enable it to make recommendations on these problems other than to state that they deserve continuing study and consideration at all levels of government. The ORRRC gave considerable attention to this subject and made a number of recommendations, some of which have been implemented.

VI. ROLE OF FEDERAL, STATE, AND LOCAL GOVERNMENTS AND PRIVATE SECTOR

Federal, State, and local governments each play several roles in outdoor recreation; they may do research, plan, finance, acquire, develop, manage, and regulate. Often these roles are intermingled horizontally and vertically in one place, and the whole state of affairs is confused.

The present lack of any clear understanding as to what can and should be expected of each of the several levels of government in acquiring and developing recreational lands frustrates rational planning, creates unnecessary delays in making decisions, and is likely to result in misallocation of land purchase resources. The lack of clarity as to the scope of public and private roles is also a source of friction and delay.

Recognizing these difficulties the Recreation Advisory Council and its successor Council on Recreation and Natural Beauty have sought to develop policy guidelines to define more clearly the intended scope of Federal, State, and private action. These guidelines have not, however, been sufficiently definitive to improve the situation. Thus, rather than relying on generally applicable criteria the Federal Government has on an *ad hoc* basis had to identify those projects which appeared to have the highest priority for Federal support within the authorized level of expenditure from appropriations and from the Land and Water Conservation Fund. The portion of this fund allocated to Federal acquisitions versus grants in aid to States for acquisition and development also has been a matter for annual negotiation (a 60-40 to 55-45 split has resulted).

Currently the Bureau of Outdoor Recreation is assisting the Council on Recreation and Natural Beauty in developing a National recreation plan. The panel does not know the specificity with which the plan developed will address the problem of establishing criteria to define Federal, State, and local government and private roles. Although it is not possible to advance a firm proposal in an area that has for so many years eluded those most immediately involved, it should be emphasized strongly that many of the difficulties in meeting marine recreation needs are a result of present ambiguities in the roles of various governmental levels and in private industry. Firmer guidelines are needed to avoid confusion that leads to inaction.

It seems apparent that new governmental arrangements will be needed, especially to provide for the recreation need of our sprawling metropolitan areas and in general to provide for proper allocation of coastal lands. The multiple use concept must be applied as consistently as possible so that no single use or group of uses of the coastal zone's resources are allowed to exclude other uses. To accomplish this it appears that a mechanism must be established between Federal, State, and local governments for the determination of coastal zone shoreline use. The recommendation of ORRRC that the States should occupy the pivotal role in planning and providing for public recreation opportunities not adequately provided by private action is endorsed.

Recommendation:

States establishing coastal zone authorities should take steps to assure adequate representation of the various recreation interests in the area.

VII. ACQUISITION

Access to coastal areas for recreation purposes can be achieved through utilizing existing facilities and through such regulatory methods as zoning, easements, or use permits to allow development of additional facilities. However, these means do not suffice in all areas and it then becomes necessary for governments to acquire coastal lands in order that the public can control their use.

A. Financing

The Land and Water Conservation Fund is the main source of assistance to Federal and State agencies for the acquisition and development of outdoor recreation areas. Prior to July 1968 the Fund derived its revenue from the sale of excess Federal property, marine motorboat fuel tax, and entrance and user fees on Federal recreation areas. These revenue sources have not come up to original estimates, and on July 16, 1968 the President signed an amendment to the Land and Water Conservation Fund Act which doubles the Federal outlay for parks and recreation lands to $200 million a year for the next five years and permits allocation of Outer Continental Shelf oil and mineral leasing revenues to the Fund in amounts required to bring the Fund's revenues up to the $200 million annual allotment. However, because of Government-wide budgetary cutbacks it is anticipated that the fund will operate on a budget of about $90 million in Fiscal Year 1969.

Under the Pittman-Robinson and Dingell-Johnson programs, special taxes on sporting arms and ammunition and fishing tackle (10 per cent) are apportioned to the States for fish and wildlife restoration measures.

National Wildlife Refuges are acquired with Revenues from Duck Stamps which are in effect, a Federal license to hunt waterfowl. Funds from this source were supplemented by Congress by $10 million in 1964, $7.5 million in 1966 and $6 million in 1967, in order to acquire additional refuges before escalating prices made acquisition economically unfeasible.

Virtually all States require paid licenses to hunt and fish in fresh water, revenues from which support all or most of the activities in their fish and game departments. However, only 6 of the 24 coastal States have a salt-water license. This has seriously limited effective management of marine sport fisheries by the States that are reluctant to support areas which do not provide revenue.

Recommendations:

Coastal States that do not presently require licenses for fishing in salt water should begin requiring licenses. Funds should be used to improve management of sport fisheries in coastal waters. Implementation would be eased if out-of-State licenses could be honored on a reciprocal basis.

The Bureau of Outdoor Recreation has found that the rate of increases in values of land suitable for public recreation is rising considerably faster than the 5 to 10 per cent annual increase generally applicable to land prices. The price of land along coastal and Great Lakes shorelines is skyrocketing, and it is argued that prompt acquisition for recreational purpose is the only practical solution. This argument appears sound, providing the acquisitions are selected according to a system of priorities determined by an overall plan tailored to the needs for recreational land against the needs for seashore land for other vital activities of the Nation.

Development of already-acquired recreational land should proceed at an orderly pace along with acquisition of new lands.

It appears that the financing of land acquisition and development should continue to be mainly from user fees and special taxes rather than from the general fund. Those who use recreational areas should be willing to pay. At the same time, it is recognized that the disadvantaged generally cannot afford to pay for recreation, and their participation will require public subsidy.

A problem in funding land acquisition under the Land and Water Conservation Fund Act arises when a State is unable to provide its share to match Federal funds on a 50-50 basis. Evidently this situation arises from time to time but the panel is not able to judge the seriousness of the problem. An increase in user fees at State parks to provide more monies for acquisition is one solution that is feasible in most cases.

One possible device that needs exploring is financing land acquisition in advance of need through discount bonds instead of conventional interest-bearing bonds. With the discount bond, interest accrues over the life of the bond and is paid at maturity. A State or municipality issuing the discount bond could thereby defer raising the tax rate to finance interest payments. Although we know of no precedent for this kind of State-local funding, some States and municipalities have shown considerable ingenuity in working out arrangements with private firms for plant construction, and there should be no great difficulty in working out a discount bond arrangement.

Constitutions or statutes of most States would probably have to be amended to permit discount bonds and, because of the lack of precedent, a market would have to be cultivated. The Federal Government might assist, at minimal cost to itself, by insuring or guaranteeing such issues.

B. Alternatives to Acquisition

Although acquisition of land for outdoor recreation and related purposes will continue to be needed, it is often not necessary to buy all the rights to open land in order for the public to enjoy its benefits. Only the rights needed should be purchased, such as the right of access, for example, or development rights to protect a scenic vista.

These less-than-full rights devices offer much greater potential than has been realized. One of the problems is that although the techniques are known, few have had experience using them. Demonstration projects and full reporting of case histories are needed. Every recreation and open space land acquisition program in the country is being curtailed because of public fund limitations for full-time acquisition.

Zoning in the marine area is a means for preserving opportunities for recreation without undertaking the high costs of acquiring land. However, zoning is a weak tool susceptible to strong political pressures in the absence of comprehensive plans for multiple use of large areas of coastal lands and adjacent waters. The State coastal zone authorities described in the Report of the Panel on Management and Development of the Coastal Zone provide a mechanism for developing such comprehensive plans that can provide a framework for zoning for recreation uses.

Urban renewal in coastal and Great Lake cities provides an opportunity to restore waterfronts and frame their natural setting for aesthetic appeal. A view of the ocean, a bay or estuary is an important asset, as evidenced by the premium put on houses and apartments with such a view.

Many high-density parks established years ago in or near metropolitan areas can no longer be used for swimming or boating because of pollution. Upgrading of water quality will restore intended uses of these areas.

Another alternative to acquiring more land is more intensive development of facilities on existing areas. More campsites, parking areas, and picnic tables are needed in some recreation areas. Care should be taken, however, to avoid destroying the natural assets of an area which attract people in the first place.

As noted in an earlier recommendation, the potential for compatible outdoor recreation at coastal National wildlife refuges and military reservations should be reviewed.

Provision of adequate parking area for automobiles and trailers must go hand in hand with the procurement of access for boating if large areas of water are to be made available to the public.

The 1965 Oregon legislature action designating the entire ocean shoreline public property as a State recreation area, and the establishment of a State seashore conservation area by the Washington legislature in 1967 are also cited as alternatives to acquiring more land.

Recommendation:

Federal, State, and local governments should give primary emphasis to acquiring access to the shores for purposes of recreation. Zoning and other regulatory methods tied to comprehensive planning developed by State coastal zone authorities need to be employed vigorously. Steps short of acquisition should be used to the extent feasible, but when necessary, land should be acquired through inventive financing arrangements that recognize the need to move promptly.

VIII. UNDERSEAS RECREATIONAL ACTIVITIES AND THE NEED FOR SAFETY MEASURES

The rapid growth of recreation is creating hazards in marine areas. This is attributable partly to competing uses in increasingly congested areas; for example, power boats can be a menace to small sailing craft and swimmers. Partly it is because there is little regulation of recreation. Children who would not qualify for a license to drive an automobile can operate a power boat with impunity. Recreation boats and equipment have usually not been required to meet safety standards but there is legislation pending that would have the Coast Guard certify the safety of boats and equipment. Zoning of uses of coastal areas will have to give greater attention to accommodating recreation activities in the interest of safety as well as pleasure.

However, to the problems of maintaining safety standards for conventional recreation activities, there have been added the dangers involved in activities under the surface of the sea. The dangers inherent in underseas recreational activity will require new legislation and new missions for activities engaged in ensuring the safety of personnel in the ocean areas.

Legislation is required to ensure the safety of operations in civilian submersibles which are used either for recreational or industrial purposes. Certification of submersibles by the Coast Guard is a necessary measure to minimize loss of life and equipment in this new underseas activity. The certification would necessarily include adequate safety equipment and features and proper manning maintenance and construction standards. Regulations for the safe operation of submersibles is also needed to include safety signals, rules of the road submerged, and safe patterns of transit in the same manner as flight plans.

Skin divers, snorkellers, and scuba swimmers are rapidly increasing. The incidence of casualties in these relatively new underseas activities has been comparatively high owing to lack of close supervision, safety standards, regulations and safety equipment. There is a need for decompression chambers, readily available in areas of considerable underwater swimming activity, and a need for rapid transportation of such facilities, close to the scene of an incident to reduce the effects of "bends."

It is recommended that the Coast Guard integrate this type of safety equipment with their rescue helicopter capability and geographically placed rescue stations to provide a fast response in coastal areas for underwater swimmers' decompression.

Regulations for underwater-swimming activity will be, for the most part, of State or local origin. However, coordination of undersea swimming activity with military and industrial activity in specific areas of the ocean should be a Coast Guard District activity. Since such swimming activity may involve the use of dangerous underwater hunting weapons there will be a need for a policing authority and regulations, both as to safety features and use of weapons. The Coast Guard should be designated as the policing and law enforcement activity.

Regulations as to cleanliness of compressed air or gas mixtures for civilian consumption will be required. The development of underseas observation facilities, including restaurants and marinas, will shortly require the establishment of safety standards in construction and operation. Federal help in planning State laws is indicated to ensure the safety of personnel and equipment in this new underseas activity.

With the development of several National underwater parks planned for the next decade following the lead of Florida's John Pennekamp Coral Reef State Park, regulations governing activity within such preserves is required and legislation to ensure safety of personnel within such preserves is needed.

Recommendation:

The Coast Guard should be provided the necessary legislative authorization to support safety requirements for recreation in coastal areas. The agency should be authorized to certify the safety of boats, civilian submersibles, and equipment, and to issue operating regulations for the submersibles.

IX. RESEARCH

Previous research has been traditionally oriented to resources, and there is a serious deficiency in socioeconomic research. In our rapidly changing society planning and predicting must take into account changes in income, mobility, amounts of leisure time, increasing urbanization, age distribution, and a host of other factors.

Little has been accomplished in measuring demand in the economic sense, *i.e.*, determining the relationship between consumption and pricing.

On the other hand, even where monetary benefits are assigned to recreation, these values only poorly reflect the essential element of quality. Research is needed to explore means to weight explicitly non-market benefits, together with benefits for which dollar market values are available.

Cost sharing is another major problem requiring research. Funds are derived from a combination of general taxes, special taxes, and user fees. Equity considerations call for research to identify better the many and diffuse beneficiaries of recreation programs.

The person who goes to the ocean for his recreation activities needs to have it clean, uncluttered, and pleasing. Likewise, the person who invests in facilities to satisfy these interests needs to have some assurance that his investment will be protected by zoning and other procedures that protect and stabilize the environment. As Chapter 3 of the Report of the Panel on Management and Development of the Coastal Zone points out, the most serious disturbances to the coastal environment are caused by man, and we are only beginning to understand these disturbances and their effects. Systematic studies of preventive or corrective action and a full evaluation of man's efforts are necessary to realize the potential of our coastal resources and to prevent their destruction.

Appendix A **Contributors to Panel Report**

Section 1-Fisheries

D. L. Alverson,[1] Bureau of Commercial Fisheries
W. M. Chapman,[1] Ralston Purina Company
Harold Crowther,[1] Director, Bureau of Commercial Fisheries
Jacob Dykstra,[1] Point Judith Fishermen's Cooperative, Narraganset, Rhode Island
Robert Kinney,[1] Gorton Seafood
J. L. McHugh, Department of the Interior
Donald McKernan,[1] Department of State
William Newman, Bureau of Commercial Fisheries
Giulio Pontecorvo,[1] Columbia University
William Royce,[1] College of Fisheries, University of Washington
M. B. Schaefer, Science Advisor, Department of the Interior
Harold Lokken, Halibut Vessel Owners Association, Seattle
Abram Tunison, Deputy Director, Bureau of Sport Fisheries and Wildlife
Lawrence Van Meir, Bureau of Commercial Fisheries

Section 2-Minerals

Admiral D. Acuff, Assistant Chief, Conservation Division, Geological Survey
Willard Bascom,[1] Ocean Science & Engineering, Inc. Washington, D. C.
Alfred J. Bodenlos, Sulphur Commodity Geologist, Geological Survey
David B. Brooks,[1] Chief, Division of Economic Analysis, Bureau of Mines
Arthur P. Butler, Uranium Commodity Geologist, Geological Survey
Michael D. Cruickshank,[1] Mining Engineer, Bureau of Mines
Thor H. Kiilsgaard, Chief, Resources Research Branch, Geological Survey
Frederick C. Kruger, Executive Head, Department of Mineral Engineering, Stanford University
Frank D. Lamb, Deputy Assistant Director and Staff, Bureau of Mines.
Francis L. LaQue, Vice President, The International Nickel Company, Inc.
Vincent E. McKelvey,[1] Research Geologist, Geological Survey
C. B. Manula, Assistant Professor of Mining Engineering, Pennsylvania State University
Charles W. Merrill, Chief, Division of Minerals, Bureau of Mines
Arthur P. Nelson,[1] Chief, Bureau of Mines Marine Minerals Technology Center, Tiburon, California
John W. Padan, Mining Engineer, Bureau of Mines
Charles M. Romanowitz, Dredging Consultant, Bureau of Mines
Rarke D. Snaveley, Chief, Office of Marine Geology and Hydrology, Geological Survey
Thomas P. Thayer, Chromite Commodity Geologist, Geological Survey
Joshua I. Tracey, Marine Geologist, Geological Survey
R. Venkataramani, Graduate Assistant, Pennsylvania University
Frank H. Wang,[1] Marine Geologist, Geological Survey
Russell G. Wayland,[1] Chief, Conservation Division, Geological Survey
Robert A. Weeks, Resource Specialist, Geological Survey

Section 3-Oil and Gas

Morris A. Adelman,[1] Professor of Economics, Massachusetts Institute of Technology
Dale M. Andrus,[1] Bureau of Land Management, Department of the Interior
F. G. Blake,[1] Chevron Oil Field Research Company
W. A. Bramlette,[1] Operations Manager, Humble Oil & Refining Company
Creighton A. Burk, Mobil Oil Corporation
Robert F. Evans, Regional Oil and Gas Supervisior, Gulf Coast Region, Geological Survey
Michel T. Halbouty,[1] Consulting Geologist and Petroleum Engineer
Hollis Hedberg, Department of Geological and Geophysical Sciences, Princeton University
Thomas A. Hendricks,[1] Assistant Chief Geologist, Geological Survey
Mason L. Hill,[1] Exploration Manager, Atlantic Richfield Company
Stephen L. McDonald,[1] Professor of Economics, University of Texas
Vincent E. McKelvey,[1] Resource Specialist, Geological Survey
C. H. Siebenhausen,[1] Shell Oil Company
Donald W. Solanas, Regional Oil and Gas Supervisor, West Coast Region, Geological Survey
Russell G. Wayland,[1] Chief, Conservation Division, Geological Survey

Section 4-Water

Jack A. Hunter, Director, Office of Saline Water
W. F. McIlhenny,[1] Dow Chemical Company
E. F. Miller, Office of Saline Water
John G. Muller,[1] Struthers Research & Development Corp.
Roy E. Oltman, Geological Survey
James L. Powell, Jr., Office of Saline Water
Milton S. Sacks, Office of Saline Water
Sam Shiozawa,[1] Office of Saline Water
Joseph E. Upson,[1] Geological Survey
W.R. Williamson,[1] American Machine & Foundry Company

Section 5-Power

Joseph E. Guidry,[1] Water and Power Development, Department of the Interior

Section 6-Recreation

Gilbert H. Cross, Loeb, Rhoades & Co.
Andrew G. Feil, National Park Service
Jack L. Knetsch, Natural Resources Policy Center, George Washington University
A. Heaton Underhill, Deputy Director, Bureau of Outdoor Recreation

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[1] Indicates technical reviewer.

Part VIII

Report of the International Panel

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Preface

The International Panel has not attempted to examine all international aspects of the uses of the oceans. In the time available to us, we have concentrated upon those problems which we thought were most important to advancement of the objectives of the Marine Resources and Engineering Development Act of 1966.

The problems to which we addressed ourselves are on the current agendas of our own government, the United Nations General Assembly and many international organizations within the United Nations system. Our report purports to describe the status of these problems on these various agendas as of September 1, 1968. Printing deadlines made it impossible to carry our account beyond this date.

We thank the many officials concerned with international marine affairs in the Department of State, the Department of Defense and the Department of the Interior, whose cooperation greatly lightened our burdens.

We acknowledge our indebtedness to the many sources cited in the report and especially to the following three outstanding studies which were commissioned by the National Council on Marine Resources and Engineering Development:

Professor Louis Henkin, Law for the Sea's Mineral Resources (1967).

Professor William T. Burke, International Legal Problems of Scientific Research in the Oceans (1967).

Professor Paul M. Dodyk, The International Law of Ocean Fisheries (1967).

Lieutenant Bernard H. Oxman, USNR, Assistant Head, Law of the Sea Branch, International Law Division, Office of the Judge Advocate General, prepared a report entitled *The Preparation of Article 1 of the Convention on the Continental Shelf.*[1] The section of Chapter 6 dealing with oil pollution is based on a paper prepared for the panel by Professor Thomas A. Clingan, Jr., Professor of Law, George Washington University and Richard Springer, a student at the Harvard Law School. For this assistance, the panel expresses its thanks.

The principal recommendations in the report relating to mineral resources were discussed with members of the National Petroleum Council's Committee on Petroleum Resources Under the Ocean Floor and the American Bar Association's Consulting Committee on Marine Resources which consists of representatives of the American Bar Association's Section of Natural Resources Law, Section of International and Comparative Law and Standing Committee on Peace and Law through the United Nations. The principal recommendations relating to scientific inquiry were discussed with members of the National Academy of Sciences' Committee on Oceanography.

From time to time, we received stimulating advice and suggestions from Ambassador Donald McKernan, Dr. Wilbert McLeod Chapman, Director, Marine Resources of the Ralston Purina Company; Dr. M. B. Schaefer, Science Advisor to the Secretary of the Interior, Dr. Francis T. Christy, Resources for the Future Inc., and Mr. Benjamin V. Cohen.

We are grateful, especially, for the willing and able assistance of our Executive Secretary, Mr. David S. Browning.

The members of the International Panel, of course, bear sole responsibility for the contents of the report.

Carl A. Auerbach, *Chairman*
Jacob Blaustein
Leon Jaworski

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[1] Available at Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 22151, PB No. 182100.

In its deliberations concerning the international aspects of the uses of the oceans, the International Panel was guided by the policies and objectives enunciated by Congress in the Marine Resources and Engineering Development Act of 1966[1] and by the President in implementing the Act.

I. POLICIES DECLARED BY CONGRESS

The policies and objectives declared by Congress in section 2 of the Act seek to safeguard the national interest of the United States. The marine science activities of the United States must be conducted so as to contribute to the "preservation of the role of the United States as a leader in marine science and resource development" and to the "encouragement of private investment enterprise in exploration, technological development, marine commerce, and economic utilization of the resources of the marine environment." The United States must develop, encourage and maintain a "coordinated, comprehensive, and long-range national program in marine science" that will "assist in . . . enhancement of . . . national security" and in "the rehabilitation of our commercial fisheries."

But the Act also recognizes that the national interest in marine science programs and activities is intertwined with the interests of the peoples of the whole world. It proclaims that the national program, which it is United States policy to effectuate, must be "for the benefit of mankind." Furthermore, the means employed to effectuate this program must further the objective of "cooperation by the United States with other nations and groups of nations and international organizations in marine science activities when such cooperation is in the national interest."

II. POLICIES DECLARED BY THE PRESIDENT

In his first Report to the Congress under the Act, President Johnson challenged the country to encounter the "depth of the sea" as "a new environment for man's exploration and development."[2] The President promised: "We shall bring to the challenge of the ocean depths—as we have brought to the challenge of outer space—a determination to work with all nations to develop the seas for the benefit of mankind."[3] To this end, he pledged:

The vast food reserves of the sea must be developed to help end the tragic cycle of famine and despair.

* * *

The wealth of the ocean floor must be freed for the benefit of all people.

Finally, the seas must be used as pathways to improved international understanding and cooperation.[4]

At a time when the peoples of the world live under a threat of nuclear holocaust and the United States is engaged in a bitter, armed conflict far from its shores, it is vital to encourage international activities that emphasize the common interests of all nations and their peoples. The International Panel shares President Johnson's conviction that marine scientific inquiry and resource development offer realistic opportunities to benefit mankind.

With the necessary international cooperation, the living resources of the sea can make a significant contribution to the prevention of world-wide malnutrition and disease.

Scientists of all nations share the interest in conducting the global investigations which are essential to observe, describe and understand the physical, geological, chemical and biological phenomena of the marine environment. International scientific cooperation will be necessary to conduct these investigations and attain an understanding of the marine environment in time to benefit the living generations of mankind.

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[1] Pub.L. 89-454, 80 Stat. 203, June 17, 1966, 33 U.S.C. §§1101-08 (1967). The Act was amended by Pub. L. 89-688, Oct. 15, 1966, 80 Stat. 1001, 33 U.S.C. §§1121-24 (1967), which provided for the sea grant colleges and programs.

[2] *Marine Science Affairs—A Year of Transition,* the First Report of the President to the Congress on Marine Resources and Engineering Development at v. (1967).

[3] *Ibid.*

[4] *Id.* at iii.

Exploration and exploitation of the mineral resources of the ocean depths may offer equally significant opportunities to benefit all nations and promote international peace and order. In these vast areas of untold riches few, if any, national economic interests have been vested, nor have the nations of the world as yet any fixed political positions or attitudes on the legal-political framework within which such exploration and exploitation should be conducted. There is the opportunity, therefore, to design a framework that will eliminate international conflict from this area of human endeavor. To realize this opportunity, President Johnson has warned:

> *Under no circumstances must we ever allow the prospect of rich harvest and mineral wealth to create a new form of colonial competition among the maritime nations. We must be careful to avoid a race to grab and to hold the lands under the high seas. We must ensure that the deep seas and the ocean bottoms are, and remain, the legacy of all human beings.*[5]

In light of the objectives proclaimed by Congress and the President, it would be ironic if the oceans provided a new dimension for the nuclear arms race. In signing the nuclear nonproliferation treaty on July 1, 1968, President Johnson pointed out that it committed the nuclear powers "to move forward towards effective measures of arms control and disarmament."[6] The President, therefore, saw the treaty as the foundation for "additional measures to halt the nuclear arms race"[7] and took this occasion to announce that the Union of Soviet Socialist Republics and the United States had agreed "to enter in the nearest future into discussions on the limitation and reduction of both offensive strategic nuclear weapons delivery systems and systems of defense against ballistic missiles."[8]

Consistent with the obligations the United States is to assume under the nuclear nonproliferation treaty, the United States Representative to the Legal Working Group of the United Nations General Assembly's Ad Hoc Committee to Study the Peaceful Uses of the Sea-Bed and Ocean Floor Beyond the Limits of National Jurisdiction introduced a draft resolution, on June 28, 1968, requesting the Eighteen-Nation Disarmament Committee of the United Nations "to take up the question of arms limitation on the sea-bed and ocean floor with a view to defining those factors vital to a workable, verifiable and effective international agreement which would prevent the use of this new environment for the emplacement of weapons of mass destruction."[9] The President reiterated this request in a message to the Eighteen-Nation Disarmament Committee on July 16, 1968.[10]

Furthermore, on August 23, 1968, Mr. David H. Popper, United States Representative to the Ad Hoc Committee informed it that the United States "supports the adoption of a General Assembly resolution declaring that the seabed and deep ocean floor should be used exclusively for peaceful purposes," with the understanding that "the test of whether an activity is 'peaceful' is whether it is consistent with the United Nations Charter and other obligations of international law." Mr. Popper pointed out that the United States had previously supported, in the Space Treaty of 1967, the use exclusively for peaceful purposes of the moon and other celestial bodies, with the same understanding. He explained further:

> *. . . considering that the term 'peaceful purposes' does not preclude military activities generally, specific limitations on certain military activities will require the negotiation of a detailed arms control agreement. Military activities not precluded by such agreements would continue to be conducted in accordance with the principle of*

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[5] President Johnson's Remarks at the commissioning of the new research ship, the "Oceanographer," July 13, 1966, 2 Weekly Compilations of Presidential Documents 930-31 (1966).

[6] President Johnson's Remarks in Washington, D.C., July 1, 1968, before the signing of the nuclear nonproliferation treaty, The Minneapolis Tribune, July 2, 1968, p. 29.

[7] *Ibid.*

[8] *Ibid.*

[9] Draft Resolution of United States on Preventing the Emplacement of Weapons of Mass Destruction on the Sea-Bed and Ocean Floor, United States Mission to the United Nations, Press Release U.S.U.N.–107 (68), June 28, 1968. The draft resolution was presented by Mr. Leonard C. Meeker, the State Department's Legal Adviser.

[10] Message from the President to the opening of the 18-Nation Disarmament Committee Meeting in Geneva, July 16, 1968.

freedom of the seas and exclusively for peaceful purposes.

The International Panel supports these actions taken by the United States Government. In our view the danger that the deployment of nuclear and other weapons of mass destruction designed for use on the bed of the seas may upset the equilibrium of mutual deterrence on which peace depends outweighs the advantages of locating such weapons systems on the ocean floor. But any agreement prohibiting such deployment of weapons of mass destruction should be negotiated in a broader arms-control context and not in the context of devising frameworks for the exploration and exploitation of marine resources.

I. A NEW INTERNATIONAL LEGAL-POLITICAL FRAMEWORK FOR EXPLORING AND EXPLOITING THE MINERAL RESOURCES UNDERLYING THE HIGH SEAS

The United States should take the initiative in proposing a new framework containing the following provisions:

A. A Redefined Continental Shelf

The continental shelf of each coastal State, for purposes of the Convention on the Continental Shelf, shall be redefined so that its seaward limit is fixed at the 200 meter (656 feet) isobath or 50 nautical miles from the baselines used for measuring the breadth of its territorial sea, whichever alternative gives the coastal State the greater area for permanent, exclusive mineral resources exploration and exploitation.

B. An Intermediate Zone

An intermediate zone should be created off the coast of each State encompassing the bed of the deep seas and its subsoil, i.e., the area beyond the continental shelf as redefined, but only to the 2,500 meter (8,200 feet) isobath or 100 nautical miles from the baselines used for measuring the breadth of the territorial sea, whichever alternative gives the coastal State the greater area for the purposes for which the intermediate zone is created. Only the appropriate coastal State or its licensees shall be authorized to explore and exploit the mineral resources of the bed of the intermediate zone and its subsoil. In all other respects, such exploration and exploitation shall be subject to the following provisions governing the bed of the deep seas and its subsoil.

C. An International Registry Authority

1. All claims to explore or exploit mineral resources in a particular area of the deep seas shall be registered with an International Registry Authority. Only a State, or an association of States, shall be eligible to register such claims on behalf of a business entity which may or may not be its national. Only the appropriate coastal State shall be authorized to register a claim in its intermediate zone.

2. The Registry Authority shall register claims on a "first come, first registered" basis, provided only that its standards with respect to technical and financial competence to undertake the task are satisfied.

3. Registration of a claim to explore shall confer upon the State Registrant the exclusive right to engage in, or authorize, such exploration, subject to maximum area limitations and requirements as to the time within which the resources must be proven. Failure to comply with these conditions shall subject the registered claim to revocation.

4. Upon proof of discovery, the Registry Authority shall convert the registered claim to exploration into a registered claim to exploitation.

5. Registration of a claim to exploit shall confer upon the State Registrant the exclusive right to engage in, or authorize, such exploitation over a large enough area and long enough time to enable the producer to operate economically and to recover its original investment as well as an adequate return thereon.

Each registered claim shall also be subject to the requirement of continued exploitation which, however, may be waived from time to time by the Registry Authority for good reason. Failure to comply with this requirement shall subject the registered claim to revocation.

6. A State Registrant shall be authorized to transfer the registered claim to any other State which is a party to the agreements embodying the new framework.

7. To cover the costs of the Registry Authority, every State shall be required to pay a specified fee for each claim to explore which it registers and an additional specified fee if and when that claim is converted into a claim to exploit.

8. Upon expiration of the period of registration of a claim to explore or exploit particular mineral resources in a particular area of the deep seas, further exploration or exploitation of such resources in such area shall be subject to whatever

international legal-political framework may be in effect at that time.

9. In any conflict between a registered and an unregistered claim, the former shall prevail. Nor shall any of the benefits of registration accrue to an unregistered claim.

D. An International Fund

1. Every State registering a claim for exploitation shall be required to pay a portion of the value of the production, if any, into an International Fund to be expended for purposes specified in the agreements embodying the new framework, but excluding the general purposes of the United Nations.

2. The Registry Authority shall accept the payments from the States registering the claims but shall have nothing to do with the management of the International Fund to which it shall turn over the proceeds. The purposes and management of the Fund should be specified in the new Convention.

E. Powers and Duties of State Registrants

Each State registering a claim shall have the following powers and duties: (1) to enact legislation to implement the new framework; (2) to apply its civil and criminal laws to protect the exploration and exploitation activities under its registered claims, including the personnel engaged therein; and (3) to apply its domestic laws which are not inconsistent with the new framework to the exploration and exploitation activities under its registered claims.

F. The Limited Policing Functions of the Registry Authority

The Registry Authority shall be authorized to inspect all stations, installations, equipment and other devices used in exploration or exploitation under a registered claim.

G. Relations Between the United States as a State Registrant and the Business Entities on Whose Behalf It Will Register Claims

Congress should enact legislation embodying the following policies:

1. The Secretary of the Interior shall be authorized to register claims on behalf of the United States with the International Registry Authority and shall adopt procedures to enable business entities to apply for the registration of claims on their behalf.

2. The business entity on whose behalf the claim is registered shall be required to pay to the United States (a) the fees specified to cover the costs of the Registry Authority; and (b) the specified payments on the value of production, if any. The United States shall then remit these proceeds to the International Registry Authority which, in turn, will deliver them to the International Fund.

3. If the claim sought to be registered pertains to an area in its intermediate zone, the United States shall adopt the policies it follows in leasing rights to mineral resources exploitation on its outer continental shelf.

4. If the claim sought to be registered pertains to an area of the deep seas beyond its intermediate zone, the United States shall not use the competitive bidding procedures authorized for the intermediate zone, but shall, in every case, adopt the same policy of "first-come, first-registered" that will guide the International Registry Authority.

H. Regional Cooperation

The United States should encourage regional cooperation of States in mineral resource exploration and exploitation.

I. Dispute Settlement

The United States should ratify the Optional Protocol Concerning the Compulsory Settlement of Disputes which it has signed. Furthermore, the International Registry Authority should be empowered initially to settle disputes arising under the recommended framework, subject to review by an independent arbitration agency appointed by the Authority.

II. A RECOMMENDED DECLARATION OF PRINCIPLES BY THE UNITED NATIONS PENDING NEGOTIATION OF NEW FRAMEWORK

The principles respecting mineral resources exploration and exploitation of the deep seas, which the United States has proposed for adoption by the United Nations General Assembly, should be amended to declare that no State may claim or exercise sovereignty or sovereign rights over any area of the sea-bed or subsoil beyond the 200 meter isobath.

III. OTHER STEPS TO BE TAKEN PENDING NEGOTIATION OF NEW FRAMEWORK

a. The United States should announce that it will continue to lease rights to explore and exploit the mineral resources of the bed or subsoil underlying the high seas beyond the 200 meter isobath, subject to any new, international legal-political framework.

b. To encourage private investment enterprise in such exploration and exploitation, the United States should enact legislation to compensate private enterprise for loss of investment or expenses that may be occasioned by the fact that the international legal-political framework ultimately adopted puts the area in which it was previously engaged in exploration or exploitation of mineral resources beyond the outer limits of the redefined continental shelf.

c. The Outer Continental Shelf Lands Act should be amended to require permission from the Secretary of the Interior to engage in mineral resources exploration or exploitation in any subsea area beyond the 200-meter isobath upon such terms and conditions as the Secretary deems appropriate.

IV. AN INTERNATIONAL LEGAL-POLITICAL FRAMEWORK FOR EXPLOITING THE LIVING RESOURCES OF THE HIGH SEAS

A. The United States should seek the agreement of the nations which are parties to the International Convention for the Northwest Atlantic Fisheries to cooperate with the States Parties to the Northeast Atlantic Fisheries Convention in setting a single annual overall catch limit and single annual national catch quotas for the cod and haddock fisheries of the North Atlantic.

B. Early consideration should be given to instituting a national catch quota system in the high seas fisheries of the North Pacific Ocean as well.

C. Whenever a national catch quota system is adopted for fisheries in which it participates, the United States should adopt domestic policies aimed at restricting its effort in the fisheries in question to the minimum number of fishing units, each of maximum efficiency, required to catch its quota over a prolonged period of time. These policies should seek to achieve this aim gradually and provision should be made for any fishermen displaced by them.

D. Existing international fishery conventions should be strengthened in the following ways:

1. The geographical area of each convention should be large enough to permit fishery management on the basis of ecological units rather than species and, when necessary, to cover the territorial seas.

2. All nations participating in the fisheries should become parties to the Convention applicable thereto.

3. All important fishing nations of the world should adhere to the Convention on Fishing and Conservation of the Living Resources of the Sea.

4. Nations which are important in processing or consuming fish should be eligible to become parties to the Convention in which they are interested.

5. Fishery commissions created by fishery conventions should be adequately financed and provided with full-time staffs to furnish the scientific, technical and economic advice they need to accomplish convention objectives, particularly if some member States lack such personnel or the resources to employ them.

6. Enforcement of the convention's provisions and the commission's implementing regulations should be made more effective.

7. Dispute-settlement procedures should be agreed upon which will make the decisions of an impartial tribunal obligatory upon the States Parties to the dispute.

E. An international organization—probably the Committee on Fisheries of the United Nations Food and Agriculture Organization—should be given the responsibility (a) to recommend the establishment of new, international fishery conventions; and (b) to evaluate the operations of existing conventions and to recommend measures to improve the work of each convention, as well as to coordinate the activities of all them; with the aim of creating a world-wide system of regional fishery conventions capable of assuring the conserving and economically efficient utilization of the living resources of the seas.

F. Under the conditions specified in the Geneva Convention Resolution on "Special Situations Relating to Coastal Fisheries," some preference should be accorded the coastal State with respect to access to the fisheries of the high seas beyond the 12-mile limit.

G. Increased bilateral and multilateral aid should be given to the developing countries to improve their fisheries capabilities.

H. If the recommended system of coastal State preference should prove to be acceptable, the effort should be made to secure agreement on a narrow territorial sea and assurance of the right to pass through and fly over international straits.

I. Until the existing disagreements with the coastal States of Latin America are resolved, the policy of indemnification embodied in the Fisherman's Protective Act of 1967 should be continued. But the Act should be amended to eliminate the requirement that the amount of aid a country is scheduled to receive from the United States must be cut by the total of unpaid United States claims against it for seizing United States fishing vessels.

V. AN INTERNATIONAL LEGAL-POLITICAL FRAMEWORK FOR CONDUCTING SCIENTIFIC INQUIRY IN THE OCEANS

A. Action Within Existing Framework

The United States should take the following steps, unilaterally, to implement a policy of "easy access" for scientific inquiry:

1. Cooperative projects.

2. Fishery research in its territorial waters and exclusive fisheries zone.

To encourage international scientific cooperation, it should announce that it will consent, upon proper notice and subject to reasonable conditions, to the conduct, in its territorial waters and exclusive fisheries zone, of scientific research (including in the case of fishery research, the limited taking of fish specimens) which is part of an international cooperative project sponsored or endorsed by the Intergovernmental Oceanographic Commission.

It should define "fishery research" so that foreign scientists will be able, without its consent, to conduct research (including the limited taking of fish specimens) in its exclusive fisheries zone for the purpose of facilitating the utilization of fish exploited wholly or in large part outside the zone.

3. Research concerning the continental shelf.

The United States should declare that it will consent to the conduct of any proposed foreign scientific investigation certified by IOC as meeting the requirements for coastal State approval specified in Article 5(8) of the Convention on the Continental Shelf.

It should give the broadest possible interpretation to the terms "qualified institution" and "purely scientific research," for purposes of Article 5 (8) of the Convention on the Continental Shelf.

It should state that it is prepared to grant applications by foreign scientists for permission to conduct broad categories of research without requiring them to make repeated requests for consent to engage in individual projects falling within an approved category.

It should interpret the Convention on the Continental Shelf as requiring the prior consent of the coastal State only for research involving physical contact with the continental shelf.

B. A New International Convention, and Interim Bilateral and Regional Agreements, on Marine Scientific Research

The United States should take the initiative to propose a new international convention on marine scientific research which should embody the following provisions. Pending the negotiation of such a convention, the United States should seek to enter into bilateral and regional agreements embodying the same provisions.

1. Scientific research in the territorial waters or on and concerning the continental shelf of a coastal State may be conducted without its prior consent, *provided that* (1) the coastal State is given prior notification of (a) the intent to carry on such research, (b) the period or periods of time during which the research will be conducted and (c) a description of its objects and methods, sufficiently in advance of its commencement so that the coastal State may, if it wishes, participate or be represented in all or any part of the research; and (2) the investigators agree to publish the results of the research.

2. Fishery research (including the limited taking of fish specimens) may be conducted in the exclusive fisheries zone of any coastal State, subject to the provisos set forth above.

3. Research submersibles may be used in the conduct of scientific research otherwise authorized, even if they will not navigate on the surface, *provided that* the coastal State is also notified of the time, place and manner of their use sufficiently in advance so that it may assure safety of navigation.

4. Research bouys may be placed in any coastal State's territorial waters and provision shall be made for their protection, as well as for the protection of research buoys placed in the superjacent waters of the continental shelves or in the high seas. The coastal State, however, may specify reasonable requirements for buoy location, lighting, marking and communications in its territorial waters.

C. International Cooperation in Marine Scientific Inquiry

1. The panel approves United States initiatives to encourage international scientific cooperation.

2. The panel also endorses the position on scientific cooperation taken by the United States before the United Nations Ad Hoc Committee on the seabed.

Chapter 3 An International Legal-Political Framework for Exploring and Exploiting the Mineral Resources Underlying the High Seas

I. OBJECTIVES OF FRAMEWORK

In light of the policies laid down by Congress and the President and the present and prospective "state of the art" with respect to exploration and exploitation of the mineral resources underlying the high seas, the International Panel concludes that any international legal-political framework (i.e., the principles and rules, procedures and institutions) for the conduct of such exploration and exploitation should be judged by the extent to which it achieves the following objectives:

a. It must encourage scientific and technological efforts and the other major capital investments needed for the exploration and exploitation of the mineral resources underlying the high seas. We know little yet about the nature, extent and location of these resources, but technical capability already exists for the extraction of various submarine mineral resources down to and even beyond the 200 meter isobath.

The Panel on Marine Resources has found that the United States petroleum industry has developed a unique and successful technology for working at sea and development of this technology is continuing; that more than one-sixth of United States production of oil and gas now comes from offshore wells; and that the oil and gas underlying the high seas may offer an important opportunity to increase significantly our domestic reserves of these fossil fuels and help offset the forecasted widening gap between domestic demand and production.[1] It is estimated that 181 billion barrels of petroleum and 1,440 billion cubic feet of gas may ultimately be produced from the subsoil of the bed of the sea between the 200-meter isobath and the 2,500 meter isobath.[2]

While there is a relatively short-run prospect that this oil and gas will be exploited, the Panel on Marine Resources does not expect that large-scale exploitation of the solid mineral resources underlying the high seas will take place before the turn of the century. Economic feasibility, more than technological difficulty, stands in the way of earlier exploitation.[3]

However, advancing technology, the raw material requirements of a burgeoning world population, with consequent rising prices for certain minerals, together with the search by particular companies for assured sources of raw materials, may make it economical to exploit these minerals at greater and greater depths during the coming decades. The international legal-political framework should serve to accelerate efforts leading to such economic exploitation.

b. The international legal-political framework must give the United States and its nationals a fair chance to engage in exploration and exploitation of the mineral resources underlying the high seas.

c. The framework must provide for orderly and economic exploitation of the resources.

d. To these ends, it must recognize exclusive claims to explore and exploit the mineral resources of large enough submarine areas for long enough periods of time to provide the incentive to undertake this activity. It must further provide means to secure recognition of such claims on a basis that is fair to all nations; to protect recognized claims, while at the same time requiring the relinquishment of claims that are not properly explored or developed within fixed reasonable periods of time; and to settle peacefully any disputes that may arise.

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[1] See Report of Panel on Marine Resources. The panel also reports that technological capability now exists to conduct geophysical surveys in waters of any depth anywhere in the world.

About 100 core holes have already been drilled in waters up to nearly 5,000 feet deep. In 1961, the petroleum industry drilled several experimental core holes in 12,000 feet of water as part of the early phase of Project Mohole. A drilling ship has been launched which will be used by the petroleum industry to core short holes into the sea floor for the Joint Oceanographic Institutions' Deep Earth Sampling program (JOIDES) in waters up to 20,000 feet deep.

To date, however, the deepest water in which an exploration or development well has been drilled is 632 feet off Southern California and in the Mediterranean, off Libya. There seems to be little doubt that exploratory and production wells can now be drilled successfully in waters as deep as 1,000 feet.

Production capability, so far, has gone only to 340 feet. However, some companies believe that, in the near future, permanent platforms bearing well–head and producing equipment can be installed in 600 feet of water or more.

The panel concludes that "there are few purely physical or technological barriers to developing marine petroleum deposits, these are completely interdependent with the economic limitations." If, for example, "a large enough field could be found offshore, say several billion barrels of [petroleum] reserves, it is likely that it could be developed economically in almost any water depth with technology that exists now or which could be employed in a short time." *Ibid.*

[2] *Ibid.*

[3] *Ibid.*

e. It must otherwise contribute to national security and welfare by not interfering unduly with uses of the seas for purposes other than the exploration and exploitation of mineral resources.

f. It must seek to avoid, and not provoke, international conflict and should contribute positively to international order and welfare. To this end, it must enable all States to share the benefits of such exploitation.

g. It must be consistent with foreign-policy objectives of the United States.

h. It must minimize the creation of vested interests that will inhibit changes in the framework deemed desirable in the light of unfolding experience with actual exploration and exploitation of the mineral resources underlying the high seas.

The panel finds that the existing international legal-political framework does not achieve the above objectives.

II. EXISTING FRAMEWORK

Different frameworks now govern different parts of the oceans. We shall distinguish, for our purposes, internal waters and the territorial sea; the contiguous zone; the continental shelf; the high seas; and the bed and subsoil of the deep seas, i.e., the high seas beyond the continental shelf.

These distinctions are also significant for the exploitation of the living resources of the sea and the conduct of scientific inquiry in the oceans.

A. Internal Waters and the Territorial Sea

The international Convention on the Territorial Sea and the Contiguous Zone recognizes that the sovereignty of each State extends beyond its land territory and its internal waters, "to a belt of sea adjacent to its coast, described as the territorial sea" and "to the air space over the territorial sea as well as to its bed and subsoil."[4] While the Convention does not specify the breadth of the territorial sea and claims vary from 3 to more than 200 nautical miles, [5] it has been the position of the United States that no claim to a breadth greater than three miles has received sufficient acceptance internationally to be a rule of international law.[6] The overwhelming majority of nations agrees that the breadth of the territorial sea is no greater than 12 miles.

The waters "on the landward side of the baseline of the territorial sea," as well as the rivers, lakes and canals within its land area, constitute the coastal State's "internal waters."[7]

The "normal baseline for measuring the breadth of the territorial sea is the low water line along the coast."[8] However, if the coast of a State is very irregular or fringed with islands and shoals, or if the territory of the State takes the form of an archipelago, the method of "straight baselines" may be used to draw the landward limit of the territorial sea.[9] The use of a system of straight baselines converts into "internal waters" broad stretches of waters which were formerly part of the territorial sea or of the high seas, with a resulting outward thrust of the territorial sea.

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[4] Convention on the Territorial Sea and the Contiguous Zone, adopted by the United Nations Conference on the Law of the Sea, April 29, 1958, Part I, Sec. I, Art. 1(1) and (2). The Convention became effective in 1964. 15 U.S.T. 1606, T.I.A.S. No. 5639, U.N. Doc. A/CONF. 13/L. 52(1958).

[5] The United States and 25 other members of the United Nations claim territorial seas of three nautical miles (Australia, Belgium, Canada, China, Costa Rica, Cuba, Dahomey, Denmark, Federal Republic of Germany, France, Gabon, Gambia, Ireland, Ivory Coast, Japan, Kenya, Malaysia, Malta, Morocco, Netherlands, New Zealand, Nicaragua, Poland, Trinidad and Tobago, United Kingdom); 16 countries claim territorial seas of six miles (Brazil, Ceylon, Colombia, Dominican Republic, Greece, Haiti, Israel, Italy, Portugal, Senegal, Somali Republic, South Africa, Spain, Tunisia, Turkey, Uruguay); 34 countries claim 12 miles (Algeria, Bulgaria, Burma, Cyprus, Ethiopia, Ghana, Guatemala, Honduras, Iceland, India, Indonesia, Iran, Iraq, Jamaica, Kuwait, Liberia, Libya, Malagasy Republic, Mauritania, Nigeria, Pakistan, Roumania, Saudi Arabia, Sierre Leone, Sudan, Syria, Tanzania, Thailand, Togo, Ukrainian S.S.R., U.S.S.R., United Arab Republic, Venezuela, Yemen); seven countries claim between 3 and 12 miles (Albania (10), Cambodia (5), Finland (4), Mexico (9), Norway (4), Sweden (4), Yugoslavia (10)); and 8 countries claim territorial seas between 12 and 200 or more miles (Argentina (200), Cameroun (18), Chile (50 kilometers), Ecuador (200), El Salvador (200), Guinea (130), Panama (200), Peru (200)). These data are set forth in Marine Science Affairs–A Year of Plans and Progress, Second Report of the President to the Congress on Marine Resources and Engineering Development, Table E-4, at 197-200 (1968) (hereinafter cited as Marine Science Affairs (1968)).

[6] Restatement of the Foreign Relations Law of the United States, §15, comment b and Reporter's Note 1 at 45-46 (1962). "[A]lthough it is true that the act of delimitation [of the territorial sea] is necessarily a unilateral act because only the coastal State is competent to take it, the validity of the delimitation with regard to other States depends upon international law." Anglo-Norwegian Fisheries Case, [1951] I.C.J. Rep. 116.

[7] Convention on the Territorial Sea and the Contiguous Zone, Part I, Sec. II, Art. 5 (1).

[8] *Id.*, Part I, Sec. II, Art. 3.

The principal limitation upon the sovereignty of the coastal State over its territorial sea is the "right of innocent passage through the territorial sea" accorded to ships, including warships, of all States.[10] There is no right of innocent passage, however, through the internal waters of a State, unless these waters previously had been considered as part of the territorial sea or of the high seas and became internal waters only as the result of the use of a system of straight baselines.[11]

Except as it may be limited by treaty, each coastal State has the capacity under international law to prescribe or enforce its rules of law in its internal waters and territorial sea, and it also has permanent, exclusive access to the living and non-living resources found in its internal waters or territorial sea, including the resources of the beds and the subsoil thereunder. It may exclude whomever it wishes from exploring or exploiting any resources in these waters. These claims of the coastal State are recognized even with respect to living resources which roam the high seas, so long as they may be found in territorial waters.

The Convention on the Territorial Sea and the Contiguous Zone also makes it clear that foreign fishing vessels exercising the right of innocent passage must "observe such laws and regulations as the coastal State may make and publish in order to prevent these vessels from fishing in the territorial sea."[12] The United States has enacted such laws and regulations. The Act of May 20, 1964, provides in part:

> *It is unlawful for any vessel except a vessel of the United States, or for any master or other person in charge of such vessel, to engage in the fisheries within the territorial waters of the United States, its territories and possessions and the Commonwealth of Puerto Rico, or within any waters in which the United States has the same rights in respect to fisheries as it has in its territorial waters . . . except as provided in this Act or as expressly provided in an international agreement to which the United States is a party . . . .*[13]

Whenever such action is in the national interest, the Secretaries of State and the Treasury are authorized to allow foreign vessels to fish in the waters from which they are otherwise excluded.

B. Contiguous Zone

The Convention on the High Seas defines the "high seas" to include "all parts of the sea that are not included in the territorial sea or in the internal waters of a State," and proclaims that they are "open to all nations" and "no State may validly purport to subject any part of them to its sovereignty."[14] However, the Convention on the Territorial Sea and the Contiguous Zone specifies that within a zone of the high seas contiguous to its territorial sea, each coastal State may exercise the control necessary to (1) "Prevent infringement of its customs, fiscal, immigration or sanitary regulations within its territory or territorial sea," and (2) "Punish infringement of the above regulations committed within its territory or territorial sea."[15] The breadth of the contiguous zone, however, "may not extend beyond twelve miles from the baseline from which the breadth of the territorial sea is measured."[16]

While the Convention seems to restrict the purposes for which the coastal State may exercise control in the contiguous zone, the coastal State's authority is not, in fact, so limited. So far as the exploration and exploitation of mineral resources is concerned, this Convention must be read together with the Convention on the Continental Shelf, which is controlling. So far as the exploitation of living resources is concerned, the import of the Convention on the Territorial Sea and the Contiguous Zone is lessened by the lack of agreement about the breadth of the territorial sea. Furthermore, one way or another, coastal States, including the United States, claim exclusive access to the living resources of the sea up to 12 miles and more from the baselines from which the breadth of the territorial sea is measured.[17]

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[9] *Id.*, Part I, Sec. II, Art. 4.

[10] *Id.*, Part I, Sec. III, Sub-sec. A, Art. 14.

[11] *Id.*, Part I, Sec. I, Art. 5 (2).

[12] *Id.*, Part I, Sec. III, Sub-sec. A, Art. 14(5).

[13] 78 Stat. 194 (1964), 16 U.S.C.A §1081 (Supp. 1964). Persons violating the Act are subject to fines not exceeding $10,000 or imprisonment not exceeding one year, or both. The violating vessel and its equipment are also subject to forfeiture.

[14] Convention on the High Seas, adopted by the United Nations Conference on the Law of the Sea, April 29, 1958, Arts. 1 and 2. The Convention became effective in 1962. 13 U.S.T. 2313, T.I.A.S. No. 5200, UN Doc. A/CONF. 13/L.53 and Corr. 1 (1958).

[15] Convention on the Territorial Sea and the Contiguous Zone, Part I, Art. 24 (1).

[16] *Id.*, Part II, Art. 24 (2).

C. Continental Shelf

The Convention on the Continental Shelf, which is of prime importance to this section of the report, recognizes the claim of the coastal State to exercise "sovereign rights" over the continental shelf "for the purpose of exploring it and exploiting its natural resources."[18] These rights are declared to be "exclusive" in the sense that "if the coastal State does not explore the continental shelf or exploit its natural resources, no one may undertake these activities, or make a claim to the continental shelf, without the express consent of the coastal State."[19] Accordingly, the coastal State's rights "do not depend on occupation, effective or notional, or on any express proclamation."[20]

The Convention defines the "continental shelf" as "the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 metres (656 feet) or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas;" or "the seabed and subsoil of similar submarine areas adjacent to the coasts of islands."[21] The convention also provides, however, that none of its provisions shall "prejudice the right of the Coastal State to exploit the subsoil by means of tunneling irrespective of the depth of water above the subsoil."[22]

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[17] Pub. L. 89-658, 80 Stat. 908 (1966), 16 U.S.C. §§1091-194 (Supp. II, 1967). Section I of this statute states that the United States "will exercise the same exclusive rights in respect of fisheries in the nine-mile zone [beyond the outer limits of the territorial sea] as it has in its territorial sea, subject to the continuation of traditional fishing by foreign states within this zone as may be recognized by the United States." In this way, the Act of May 20, 1964, note 13 *supra*, is made applicable to the nine-mile zone as well as to the territorial sea.

Canada, apparently, is the only country that qualifies for traditional fishing rights. See H. Rep. 2086, 89th Cong., 2d Sess., Sept. 26, 1966, 2 U.S. Code & Adm. News 3289 (1966).

Section III authorizes the President, whenever he "determines that a portion of the fisheries zone conflicts with the territorial waters or fisheries zone of another country," to "establish a seaward boundary for such portion of the zone in substitution for the seaward boundary described in Section II." The seaward boundary described in Section II is "a line drawn so that each point on the line is nine nautical miles from the nearest point" on the outer limits of the territorial sea.

As of Jan. 1, 1968, there were 123 nations in the United Nations; 103 are coastal States, 20 have no coasts. A total of 59 countries had 12-mile exclusive fishing zones, either as territorial sea or as territorial sea of less than 12 miles plus a contiguous zone of exclusive fishery jurisdiction which made a total of 12 miles. See Marine Science Affairs (1968), Table E-4, at 197-200.

[18] Convention on the Continental Shelf, adopted by the United Nations Conference on the Law of the Sea, April 29, 1958, Art. 2(1). The Convention became effective in 1964. 15 U.S.T. 471, T.I.A.S. No. 5578, U.N. Doc. A/CONF. 13/L. 55 (1958).

The Convention on the Continental Shelf codified customary international law given impetus by the Truman Proclamation of 1945. Presidential Proclamation No. 2667, Sept. 28, 1945, Policy of the United States with Respect to the Natural Resources of the Subsoil and Seabed of the Continental Shelf, 10 Fed. Reg. 12303 (1945).

[19] *Id.*, Art. 2(2).

[20] *Id.*, Art. 2(3).

[21] *Id.*, Art. 1. It should be noted that the term "continental shelf" is not confined to its geological meaning, but is given a special, legal meaning. The geological meanings of this term and of others that will shortly become significant for our purposes, which were available to the diplomats, lawyers and other specialists gathered at Geneva in 1958, are those adopted by the International Committee on the Nomenclature of Ocean Bottom Features. They are to be found in 1 Yearbook of the International Law Commission, 1956, at 131. (See also, Guilcher *et al.*, Scientific Considerations Relating to the Continental Shelf, UNESCO, Conference on the Law of the Sea, 13/2, 1957 (mimeo)). These geological meanings follow:

> **1. Continental Shelf, Shelf Edge and Borderland**
>
> The zone around the continent, extending from the low water line to the depth at which there is a marked increase of slope to a greater depth. Where this increase occurs, the term "shelf edge" is appropriate. Conventionally, the edge is taken at 100 fathoms (or 200 meters), but instances are known where the increase of slope occurs at more than 200 or less than 65 fathoms. When the zone below the low water line is highly irregular, and includes depths well in excess of those typical of continental shelves, the term "continental borderland" is appropriate.
>
> **2. Continental Slope**
>
> The declivity from the outer edge of the continental shelf or continental borderland into greater depths.
>
> **3. Borderland Slope**
>
> The declivity which marks the inner margin of the continental borderland.
>
> **4. Continental Terrace**
>
> The zone around the continents, extending from low water line to the base of the continental slope.
>
> **The Continental Rise.** This term was not used by the International Committee on Nomenclature, but we shall have occasion to use it. The "continental slope" is bounded on its seaward side by the continental rise, a vast apron of debris from the continent and of calcareous skeletal material from near the sea surface. The apron shape reflects the landward source of most of the sediment (brought by turbidity currents and suspended sediment) and its movement and redeposition by bottom currents that appear to flow parallel to the contours.
>
> The boundary between the continental slope and the continental rise is not everywhere clearly marked, owing to inadequate soundings and to the fact that sediments of the continental rise overlap the continental slope and can eventually bury it.

Emery, Geological Aspects of Sea-Floor Sovereignty, in The Law of the Sea 150 (Alexander ed. 1967).

For purposes of the Convention, the "natural resources" to which the coastal State is given permanent exclusive access include:

> *the mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or subsoil.*[23]

The exercise of the sovereign rights of the coastal State over the natural resources of the continental shelf is not to "affect the legal status of the superjacent waters as high seas, or that of the air space above those waters."[24] However, the coastal State may establish safety zones up to 500 meters around the installations and equipment it operates to explore the continental shelf and exploit its natural resources.[25] Ships of all nationalities must respect these safety zones[26] and the coastal State may take necessary measures in these zones to protect its installations and equipment.[27] But it is also obliged to undertake, in the safety zones, "all appropriate measures for the protection of the living resources of the sea from harmful agents."[28]

Furthermore, the coastal State may not operate installations or equipment, or establish safety zones around them, which would interfere with "the use of recognized sea lanes essential to international navigation."[29] The State's exploration of the continental shelf and exploitation of its mineral resources, furthermore, "must not result in any unjustifiable interference with navigation, fishing or the conservation of the living resources of the sea."[30] Subject to the coastal State's right to take "reasonable measures" to accomplish its purposes, its activities must also not "impede the laying or maintenance of submarine cables or pipelines on the continental shelf."[31]

Finally, these activities of the coastal State must not result "in any interference with fundamental oceanographic or other scientific research carried out with the intention of open publication."[32] The State's consent must be obtained "in respect of any research concerning the continental shelf and undertaken there."[33]

> *Nevertheless, the coastal State shall not normally withhold its consent if the request is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf, subject to the proviso that the coastal State shall have the right, if it so desires, to participate or to be represented in the research, and that in any event the results shall be published.*[34]

D. High Seas

Both coastal and non-coastal States may exercise the freedoms of the high seas which, according to the Convention on the High Seas, comprise (1) freedom of navigation; (2) freedom of fishing; (3) freedom to lay submarine cables and pipelines; (4) freedom to fly over the high seas; and (5) other freedoms "which are recognized by the general principles of international law."[35] But, of course, some of these freedoms are restricted and regulated pursuant to the Conventions on the Territorial Sea and the Contiguous Zone and on the Continental Shelf. The freedom to fish is also regulated by bilateral and multilateral treaties, including the Convention on Fishing and Conservation of the Living Resources of the High Seas[36] which will be considered in greater detail in Chapter 4 of the report. Furthermore, the freedoms of the high seas must "be exercised by all States with reasonable regard to the interests of other States in their exercise of the freedom of the high seas."[37]

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[22] Convention on the Continental Shelf, Art. 7.

[23] *Id.*, Art. 2(4). The Act of May 20, 1964, note 13 *supra*, also makes it unlawful for any foreign vessel "to engage in the taking of any Continental Shelf fishery resource which appertains to the United States" except as provided in the Act or "in an international agreement to which the United States is a party . . . ."

[24] *Id.*, Art. 3.

[25] *Id.*, Art. 5(2) (3).

[26] *Id.*, Art. 5(3).

[27] *Id.*, Art. 5(2).

[28] *Id.*, Art. 5(7).

[29] *Id.*, Art. 6.

[30] *Id.*, Art. 5(1).

[31] *Id.*, Art. 4.

[32] *Id.*, Art. 5(1).

[33] *Id.*, Art. 5(8).

[34] *Ibid.*

[35] Convention on the High Seas, Art. 2.

[36] Convention on Fishing and Conservation of the Living Resources of the High Seas, adopted by the United Nations Conference on the Law of the Sea, April 28, 1958. The Convention became effective in 1966. 17 U.S.T. 138, T.I.A.S. No. 5969, U.N. Doc. A/CONF. 13/L. 54 and Add. 1 (1958).

Freedom to explore and exploit the mineral resources of the seabed and subsoil of the submarine areas of the high seas is not expressly included as a freedom of the high seas. The Convention on the Continental Shelf gives the coastal State "sovereign rights" to explore the continental shelf, as defined therein, and to exploit its natural resources. The proclamation in the Convention on the High Seas that "no State may validly purport to subject any part of [the high seas] to its sovereignty" does not supersede these rights of exclusive access. Only "general principles of international law," however, govern exploration and exploitation of the mineral resources of the seabed and subsoil of the submarine areas beyond the outer limits of the continental shelf as defined by the Convention on the Continental Shelf. The International Panel agrees with Professor Louis Henkin that these general principles abound with uncertainty.[38]

E. Optional Protocol Concerning the Compulsory Settlement of Disputes

The Optional Protocol[39] authorizes any party to it to bring to the International Court of Justice any dispute, to which it is also a party, arising out of the interpretation or application of any of the provisions of the Conventions on the Law of the Sea,[40] except a dispute subject to the arbitration machinery created by the Convention on Fishing and Conservation of the Living Resources of the High Seas.[41] Disputes covered by the Protocol are declared to be within the Court's "compulsory jurisdiction."[42] However, within a period of two months after one party has notified the other that a dispute exists, the parties may agree to resort to an arbitral tribunal instead of the Court,[43] or to adopt a conciliation procedure before resorting to the Court.[44] If the conciliation procedure fails to resolve the dispute, either party may bring it before the Court.[45]

The Optional Protocol is now in force but not for the United States which has signed but not ratified it.[46]

III. SHOULD THE UNITED STATES SEEK TO CREATE A NEW FRAMEWORK?

A. Uncertainties of the Status Quo

To determine whether the United States should seek to change the existing framework, an assessment must be made of the effect of the uncertainties of the existing international legal-political framework upon exploration and exploitation of the mineral resources underlying the high seas, and upon other domestic and foreign policy objectives of the United States. The principal uncertainty derives from the language of the Convention on the Continental Shelf defining the continental shelf to extend "to the seabed and the subsoil of the submarine areas adjacent to the coast . . . to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas; . . ."

1. The Exploitability Criterion

a. Articles 2 (2) and (3) of the Convention make it clear that the coastal State may exclude any other State, or its nationals, from exploiting or exploring any of the natural resources of the seabed or subsoil of the submarine areas adjacent to the coast to a depth of 200 meters, even if neither the coastal State, nor any of its nationals, is exploiting the particular natural resource and regardless of the "state of the art" for such exploitation. Beyond the 200 meter limit, the matter is not clear.

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[37] Convention on the High Seas, Art. 2.

[38] Henkin, Law for the Sea's Mineral Resources, at 27 (A Report Prepared for the National Council on Marine Resources and Engineering Development, December 1967, published as ISHA Monograph No. 1. by the Institute for the Study of Science in Human Affairs of Columbia University (1968)).

[39] Optional Protocol of Signature Concerning the Compulsory Settlement of Disputes, signed at Geneva, April 29, 1958.

[40] *Id.*, Art. I.

[41] *Id.*, Art. II.

[42] *Id.*, Art I.

[43] *Id.*, Art III.

[44] *Id.*, Art. IV.

[45] *Ibid.*

[46] Treaties and Other International Agreements Containing Provisions on Commercial Fisheries, Marine Resources, Sport Fisheries, and Wildlife to Which the United States is Party, Senate Commerce Committee Print, 89th Cong., 1st Sess. 387 (1965).

b. It has been suggested that a coastal State's continental shelf extends only to that depth to which the technology of its own nationals is capable of exploiting a natural resource of the shelf. Thus, in reporting the bill which became the Marine Resources and Engineering Development Act, the Senate Commerce Committee explained that the Convention "conveys both specific and immediate rights and prospective or potential rights, the latter to be acquired only as a result of national effort and achievement."[47]

On the other hand, it is contended, every coastal State's continental shelf extends to that depth to which "the state of the art," i.e., the world's most advanced technology can reach, even if that technology is not the result of the coastal State's national effort and achievement.[48] The panel agrees with this latter position because of the possibility that the world's most advanced technology may "fly-the-flag" of any coastal State. However, this may not always be the case and it is arguable that a particular coastal State's continental shelf extends only to that depth to which the technological capabilities of either its own nationals, or of the nationals of any other State actually licensed, or available for licensing, by it, permit it to reach.

c. If the Senate Commerce Committee's opinion is accepted, the question arises whether the continental shelf beyond the 200 meter isobath may be different in extent for some natural resources, e.g., manganese nodules, if the depths reachable by the technologies for exploiting the different mineral resources vary.[49] The panel concludes that an affirmative answer to this question is implicit in the exploitability criterion. For example, it would not then be reasonable to take the depth at which a sedentary fishery may admit of exploitation as the measure of the coastal State's "sovereign rights" for the purpose of exploiting oil and gas or manganese nodules. Yet it may be argued that the literal language of the Convention gives the coastal State "sovereign rights" to explore and exploit *all* the natural resources of a particular area of the seabed and subsoil beyond 200 meters, as long as *any* natural resource in the area admits of exploitation.

d. If the Senate Commerce Committee's opinion is not accepted, the question may be raised whether the limits of the continental shelf must be uniform for all coastal States. The "state-of-the-art" may be capable of exploiting a particular mineral resource at depths up to 2,500 meters, for example, off the coast of one State but not off the coast of another, because of different current and wave conditions off the two coasts. It may be argued that a coastal State must prove that the "state-of-the-art" admits of exploitation of that resource at a specified depth off *its* coast, before it may exercise "sovereign rights" for the purpose of such exploitation.

In reply, it is maintained that this question is not likely to arise.

Presumably a coastal State will not begin to dig, or a company pay for a lease or license, unless it is confident that the waters admit of exploitation. If the coastal State sought to exclude another state, the latter, by seeking to dig, might in effect be agreeing that the waters admit of exploitation and thereby be proving the right of the coastal State to exclude it.[50]

e. It seems to be assumed that a particular depth "admits of" exploitation if it is technologically possible to exploit the resource at that depth. Exploitation at that depth need not be economical. "Exploitation" in this sense would mean the technical possibility of extracting the mineral resource as distinguished from the preliminary operation of exploring and opening the well or mine. Yet it is also reasonable to say that the concept of exploitability has an economic dimension, implying that it is practical to extract the resource.

| f. To Professor Goldie, the exploitability criterion was "intended to have a supplementary and

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[47] S. Rep. No. 528, 89th Cong., 1st Sess. 11 (1965).

[48] See Franklin, The Law of the Sea: Some Recent Developments 23 (Naval War College Blue Book Series No. 53, 1961). Mouton, The Continental Shelf 42 (1952); and Young, The Geneva Convention on the Continental Shelf: A First Impression, 52 Am. J. Int'l L. 733, 735 (1958).

[49] Goldie, The Contents of Davy Jones's Locker–A Proposed Regime for the Seabed and Subsoil, 22 Rutgers L. Rev. 1, 17 (1968).

[50] Henkin, *supra* note 38, at 16-17, n. 43.

subordinate function to that of the two hundred meter isobath test."[51]

> *Originally it was intended to permit a coastal State to exercise sovereign rights over continental shelf activities carried out on the continental slope and in the continental borderland in the continuation of activities begun, or connected with those carried out, in the zone between its territorial sea and the two hundred meter bathymetric contour line. The test was thus intended to provide a practical solution to day-to-day problems which would arise if the two hundred bathymetric contour line were accepted as a complete and final cut-off line.*[52]

2. The Adjacency Criterion

Meeting the exploitability criterion gives the coastal State "sovereign rights" over only the "submarine areas adjacent to the coast." Sharply different positions have been taken on the meaning of this adjacency criterion.

a. At one extreme, it has been seriously suggested that the adjacency criterion is not a limitation upon the exploitability criterion at all, but that as soon as it becomes technologically possible to exploit mineral resources to any ocean depth, the sea-bed of all the submarine areas of the world–totaling more than 128,000,000 square miles beyond the 200-meter isobath–will become part of the continental shelves of the coastal States.[53] This view would be implemented by Article 6 of the Convention which provides that if opposite or adjacent nations share a continental shelf, the boundaries between them shall be determined by applying specified principles of equidistance. These principles, in effect, would give each coastal State sovereign rights to the natural resources of the seabed and subsoil from its coasts to the median line, i.e., the line every point of which is equidistant from the coasts of the nearest States.

As a practical matter, adoption of this position would induce any prudent entrepeneur to seek the permission of some one or more coastal States–assuming he could identify them–in order to proceed with exploration for mineral resources anywhere in the oceans even before the technological capability to exploit these mineral resources was demonstrated. For as soon as such capability was shown, the resources of the area of the ocean bottom in question would belong to some coastal State or States.

Apart from the question of the desirability of such an outcome–a question which is considered in Appendix A to this report–this interpretation of the Continental Shelf Convention is the most difficult to sustain. The panel agrees with Professor Henkin that no government "would dare propose" it and "if one did, the other nations would reject it."[54] This interpretation reads the definition of the continental shelf as if the adjacency criterion were not there. It ignores the fact that the Convention, after all, sought to define the *continental shelf* and resorted to the exploitability test to effect some *limited* extension of sovereign rights.[55] There was no intention to curtail so drastically the proclamation in Article 2 of the Convention on the High Seas that "no State may validly purport to subject any part of [the high seas] to its sovereignty."

This interpretation has not been urged upon the panel by any international lawyer or industry group with whom it has discussed the question. We are led to think that it is generally discredited in this country and elsewhere.

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[51] Goldie, *supra* note 49, at 8.

[52] *Ibid.*

[53] Shigeru Oda, The Geneva Conventions: Some Suggestions to their Revisions, American Bar Association National Institute on Marine Resources, June 9, 1967, at 6-7. There is some legislative history to support this reading of the Convention. Compare 1956 International Law Commision Report, at 41; Statement by Mr. Samad of Pakistan, 6 Official Records, U.N. Conference on Law of the Sea 19, U.N. Doc. A/CONF. 13/42 (1958); Statement by Mr. Fattal of Lebanon, *id.* at 38. See also Bernfeld, Developing the Resources of the Sea–Security of Investment, 2 International Lawyer 67, 72-73 (1967).

It is estimated that the oceans cover approximately 139,000,000 square miles, of which the continental shelves up to the 200-meter isobath account for 10,422,000 square miles. See Menard and Smith, Hypsometry of Ocean Basin Provinces, 71 J. of Geophysical Research 4305, 4315 (1966).

[54] Henkin, *supra* note 38, at 19.

[55] *Id.* at 18. Professor Goldie, however, maintains that the adjacency criterion is not much of a limit because "a continental shelf region can remain 'adjacent' to a coast on its landward side and yet eventually extend out to mid-ocean areas by means of a series of claims–each successive claim adding zones onto the further side of the shelf region, which still remains 'adjacent' on its coastal side." Goldie, *supra* note 49, at 11. As we saw, Professor Goldie sees the exploitability criterion as orginally seeking to impose a limit on the claims of the coastal State.

b. The National Petroleum Council (NPC) interprets the exploitability and adjacency criteria as giving the coastal States exclusive jurisdiction (1) generally, "over the natural resources of the continental land mass seaward . . . to where the submerged portion of that land mass meets the abyssal ocean floor," i.e., over the natural resources of the geological continental shelf, continental borderlands, continental slopes, and at least the landward portions of the geological continental rises;[56] and (2) in particular instances, "(i.e., where the continent drops off sharply from near the present coastline to the abyssal ocean floor)," over the natural resources of "an area of that floor contiguous to the continent."[57] While this interpretation does not go as far as that just previously considered, it goes much further than Professor Goldie's more restrictive reading of the Convention,[58] and is without discernible limit in the "particular instances" described.

NPC argues that there is support for its view in the history of the background and negotiations leading up to the adoption of the Convention on the Continental Shelf.[59] Our study of the history of the Geneva Convention, and the work of the International Law Commission preparatory to it (see Preface, note 1), indicates that there are isolated bits and pieces of "legislative history" which may offer some support for the NPC view. There is also stronger evidence for alternative interpretations. The fact is the draftsmen of the Convention did not anticipate that advancing technology would make the exploitability criterion so central an issue. The certainty and emphatic manner that characterizes the statement of the NPC conclusions is unwarranted.

For example, to support its position, the NPC Committee maintains that the "provisions of the Geneva Convention encompass the principles on which the Truman Proclamation of 1945 was based."[60] We accept this view, but it does not support the position contended for because the Truman Proclamation applied to the continental shelf as geologically defined.[61] Furthermore, there is evidence in the legislative history that even though the legal definition of the continental shelf does not coincide with its geological definition, it was not intended to abandon "the link" to the geological shelf entirely.[62]

Essentially, NPC argues that the adjacency criterion alone–not the exploitability criterion–imposes a limit on the claims of the coastal State and that the submarine areas encompassing the geological continental shelves, continental borderlands, continental slopes, at least the landward portions of the continental rises and, in particular instances, undefined areas of the abyssal ocean floor, are still "adjacent to the coast."

However, this is certainly not the sense in which the concept of adjacency was used by the International Law Commission. Even Dr. Garcia-Amador, who was the leading proponent of the exploitability clause and upon whose words and activities NPC greatly relies, explained that the adjacency criterion "placed a very clear limitation on the submarine areas" covered by the continental shelf definition, including the exploitability criterion, because the "adjacent areas ended at the point where the slope down to the ocean bed began, which was not more than 25 miles from the coast."[63]

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[56] Petroleum Resources Under the Ocean Floor, An Interim Report By the National Petroleum Council's Committee on Petroleum Resources Under the Ocean Floor, July 9, 1968, p. 9 (hereinafter cited as NPC Interim Report). The Interim Report was adopted by the National Petroleum Council on July 9, 1968, with a Note that "nothing contained" therein "should be construed as representing U.S. policy."

[57] *Id.* at 15. It also recommends that the coastal States "bordering enclosed seas and small ocean basins adjacent to and closely related to the continents should reserve to themselves full options with respect to the establishment of exclusive jurisdiction over seabed resources." *Ibid.*

[58] See text accompanying notes 51 and 52 *supra*.

[59] The legislative history upon which NPC relies is summarized in Appendix B to the NPC Interim Report.

[60] NPC Interim Report, at 9.

[61] Professor Henkin points out that although the Truman Proclamation itself did not define the "continental shelf", the White House Press Release that accompanied it (See 13 Dep't State Bull. 484 (1945)) referred to the common definition of the shelf as delineated by the 100-fathom or 200-meter isobath. Henkin, *supra* note 38, at 19, n. 53. Furthermore, it is plausible to argue that since the Truman Proclamation itself used a geological term without qualification, it intended the geological definition. *Ibid.*

[62] Henkin, *supra* note 38, at 18. For example, in its final report, the International Law Commission stated that while it was departing "to some extent from the geological concept," it was "adopting, to a certain extent, the geological test for the 'continental shelf' as the basis of the juridical definition of the term." 1956 International Law Commission Report 41. Although at one time it was proposed that the term "submarine area" be substituted for "continental shelf" in order to get away from the geological connotation of that term, the proposal was rejected because, in part, "the term 'submarine areas' used without further explanation would not give a sufficient indication of the nature of the areas in question." *Id.* at 42.

The draftsmen of the Geneva Convention were well aware of the distinction between the "shelf" and the "slope." Had they intended to convey the meaning NPC now advances, they would have used the term "slope" or, more simply, eliminated the terms "shelf" and "slope" and the reference to 200 meters as well; they would have defined the "submarine areas" over which sovereign rights to mineral resources exploration and exploitation were being accorded as limited only by the adjacency and exploitability criteria.

c. At the other extreme, it may be argued with reason that the definition in the Convention makes the adjacency criterion supreme even over the 200 meter criterion, so that all the area out to a depth of 200 meters is not, by that fact alone, part of a coastal State's continental shelf but is so only if it is all "adjacent" to the coast. In some parts of the world, the geological continental shelf extends to a depth less than 200 meters yet to a distance so far from the coast that at some point it is no longer reasonably "adjacent" to it.

d. As the "least implausible interpretation" of the continental shelf definition, Professor Henkin suggests that the 200-meter isobath limit, which in fact corresponds roughly to the edge of the geological shelf, should be viewed "as an effort by lawyers to approximate the geological definition in a form that affords precision and clarity."[64] The exploitability criterion, on the other hand, should be viewed as giving the coastal State sovereign rights for the purpose of exploiting the natural resources of any part of the geological continental shelf underlying waters deeper than 200 meters, if and when it becomes technologically possible to extract the resources from such depths.[65]

e. However, Professor Henkin acknowledges that this view does not express the precise intention of the draftsmen of the Convention who wished, by the exploitability criterion, to give rights "to coastal States in waters less than 200 meters deep that were not on a geological continental shelf, as in the Persian Gulf," as well as to States, particularly in Latin America, "whose coasts dropped almost immediately to great depths and who insisted on 'equal' treatment, on getting something out of this new regime."[66]

Accordingly, it might be suggested, the "200 meter isobath . . . should be the limit of the shelf for nations with 'normal' coast lines, and the exploitability test should apply only to those who do not have a geological continental shelf."[67] But the language of the Convention makes no such distinction.

It is interesting to note, in this connection, that the NPC recognizes that an interpretation of the definition of the "continental shelf" which would fix its outer limit at the base of the continental slope would only magnify the "inequality" between States with "normal" shelves and slopes and those whose coasts drop off sharply to the abyssal ocean floor. For this reason, the NPC would include an area of the abyssal ocean floor in the definition of the "continental shelf" *of those States.* But clearly, the legislative history of the Convention on the Continental Shelf gives no support whatsoever for such an "interpretation."

f. Professor Henkin sees no way "to 'redefine' the outer limit" of the continental shelf "by interpretation of the Convention."[68] As guidelines to suggest when a coastal State may have reached too far, he proposes:

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[63] Statement of Dr. Garcia-Amador in I 1956 ILC Yearbook, at 135. It is difficult to reconcile this statement, we realize, with the exploitability criterion itself. Professor Henkin suggests that it "is open to question" whether "this view of adjacency survived the addition of the exploitability clause." Henkin, *supra* note 38, at 24, n. 72. But Dr. Garcia-Amador's statement was made *after* the exploitability criterion was added. See also, McDougal and Burke, The Public Order of the Oceans 685-86 (1962).

[64] Henkin, *supra* note 38, at 19. See also 1951 ILC Report, at 18; Sovereignty Over the Sea, Geographical Bulletin No. 3, at 7 (The Geographer, U.S. Dep't of State, 1965). In fact, the geological shelf averages a maximum depth of about 130 meters, with few areas beyond 200 meters. G. Pearcy, Department of State Memorandum 5.

[65] Henkin, *supra* note 38, at 19-20. This seems to be the view of Mr. Arthur H. Dean who was chairman of the United States Delegations to the 1958 and 1960 Law of the Sea Conference at Geneva. See Dean, The Law of the Sea Conference, 1958-60 and Its Aftermath, in The Law of the Sea 246 (Alexander ed. 1967). But *cf. id.* at 248.

[66] *Id.* at 20. Until technology can reach to any ocean depth, there is no possibility of "equal treatment" even under the exploitability criterion because that criterion will give a state with a "normal" continental shelf and slope a greater submarine area for mineral resources exploitation than a State whose coast drops almost immediately to great depths.

[67] Henkin, *supra* note 38, at 20-21.

[68] *Id.* at 21.

> *that the "areas adjacent to the coast" in which the coastal States have exclusive mineral rights are areas that do not take "too-big" a "bite" out of the deep-sea bed; that do not reach "too-far" from shore; where the coastal State has a legitimate interest in excluding others; where-economically and technologically-exploitation depends heavily on the coastal State. There is some support, too, for an argument that the geological shelf has not become wholly irrelevant, that a State can claim all of its geological shelf, but that over-all and in general, "adjacent" areas do not extend "too-far" beyond the geological shelves of the world.*[69]

There is little question but that the NPC view of adjacency extends too-far beyond the 200 meters, the depth of most geological shelves of the world. Considering the totality of its interests in the oceans, the United States would never have accepted the Convention on the Continental Shelf as NPC now reads it.

Professor Henkin's guidelines are based upon the justifications advanced for the Truman Proclamation of 1945. It was reasonable and just, according to the Proclamation, for the United States to assert its right of permanent, exclusive access to the mineral resources of its continental shelf:

> *since the effectiveness of measures to utilize or conserve these resources would be contingent upon cooperation and protection from the shore, since the continental shelf may be regarded as an extension of the landmass of the coastal nation and thus naturally appurtenant to it, since these resources frequently form a seaward extension of a pool or deposit lying within the territory, and since self-protection compels the coastal nation to keep close watch over activities off its shores which are of the nature necessary for the utilization of these resources.*[70]

It will be seen that two of these justifications rely upon the geological concept of the continental shelf. The first justification will have less and less applicability as technology advances to the point where exploitation of the mineral resources of the seabed and subsoil beyond the 200-meter isobath is no longer heavily dependent, technologically or economically, upon any particular coastal State. The last justification continues to be valid.

Taken together, these justifications make it very difficult to translate Professor Henkin's reasonable guidelines into depth, or distance-from shore, figures. But they were most carefully weighed by the International Panel, as we shall point out, when it fashioned its recommendations for the "intermediate zone."

3. The Submarine Areas Beyond the Limits of the Continental Shelves

The panel assumes agreement here that the definition of the continental shelf should not be so interpreted as to permit the coastal States to divide the sea-bed and subsoil of the world's oceans among themselves. That interpretation would eliminate the question to which we shall now turn: Are there general principles of international law governing exploration and exploitation of the mineral resources of the sea-bed and subsoil beyond the outer limits of the continental shelves?

No one can answer this question with certainty. International lawyers disagree on whether these resources belong to nobody *(res nullius)* or to everybody *(res communis)*. In the case of fishing and navigation, these concepts seem to be merely alternative ways of justifying the doctrine of the "freedom of the seas." Recently, however, the State Department's Deputy Legal Adviser has suggested that if the mineral resources underlying the deep seas belong to nobody *(res nullius)*, anyone may extract them and even acquire, by occupation, the right of permanent, exclusive access, for all purposes, to the submarine areas containing them.[71] If, on the other hand, these resources belong to everybody *(res communis)*, no one may extract them without permission from the international community.[72] Yet it is also reasonable to take *res communis* to mean only that no nation, by occupation, may claim the right of permanent, exclusive access to the submarine areas in question.

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[69] *Id.* at 24. There is some evidence as to what the United States thought might not be "too-far" beyond the geological shelf. Dr. John Lyman has given the Institute of Naval Studies the following view of why the United States supported the addition of the exploitability criterion:

> *At an Interamerican Conference on the Continental Shelf held at Ciudad Trujillo in 1956, [upon the results of which NPC relies heavily] the U.S. Delegation had the advance position of supporting 100 fathoms (200 meters) as the outer limit of the continental shelf. It was also provided with a detailed bathymetric chart of the East Coast, which showed that a curious platform exists off New York a short distance down the Continental Slope at a depth slightly greater than 100 fathoms. On the basis of the possible strategic importance of this special area, the U.S. Delegation cabled home and was authorized to support the "feasibility" rule, which was adopted by this Conference and subsequently by the International Law Commission and the 1958 Geneva Convention.*

[70] Presidential Proclamation No. 2667, Sept. 28, 1945, 10 Fed. Reg. 12303 (1945).

In short, the inferences one draws from either *res nullius* or *res communis* are likely to depend upon the results one prefers. Nor need these results be the same for all resources or uses of the oceans. For example, the fact that fish are a mobile and replenishable resource and minerals are immobile and exhaustible may lead to a view of either *res nullius*, or *res communis* which is different for the one resource than for the other.

Most international lawyers seem to agree that any State is free to engage in exploration and expolitation of mineral resources in any submarine area outside the limits of the continental shelf, provided it does not interfere unreasonably with the exercise of other freedoms of the high seas. The State is then entitled to keep what it finds and extracts and to protect any vessel (or platform) and installations on the sea-bed used in exploration and exploitation operations which carry its flag.[73] Article 2 of the Convention on the High Seas, which requires all States to exercise their freedoms of the high seas "with reasonable regard to the interests of other States in their exercise of" these same freedoms, would prohibit any other State from physically interfering with the operations.

However, there is no agreement that a State may acquire "sovereign rights" to explore and exploit the mineral resources of any submarine area outside the limits of the continental shelf and, consequently, the right to exclude "poachers," i.e., operators of other nations who wait until the operator carrying its flag has done the exploration and then, having avoided the costs of exploration, move in on a deposit and work in the same area.[74]

B. Do the Uncertainties of the Status Quo Promote or Inhibit Attainment of United States Objectives?

Representatives of industry with whom the International Panel has discussed this question agree that private enterprise will be deterred from exploring and exploiting the mineral resources of the sea-bed and subsoil beyond the limits of the continental shelf unless it is assured of exclusive access to such resources in a large enough area for a long enough time to make the activity profitable.[75] However, no one can reasonably advise private enterprise that the existing framework assures it of such security much beyond the 200-meter isobath.

The National Petroleum Council recommends that the United States should remove these uncertainties by declaring that it will exercise the "full rights of exclusive jurisdiction" which it thinks the Convention on the Continental Shelf gives the United States and inviting all other coastal States to join it in making similar declarations.[76] Once this is done, the NPC does not think it is urgent to create a new framework for the exploration and exploitation of the mineral resources of the sea-bed and subsoil beyond the continental margins (i.e., the continental shelves, slopes and rises) over which it would have the coastal States declare their "full rights of exclusive jurisdiction."[77] Capital and developmental competence will be preoccupied with exploiting the natural resources of the continental margins and it is "most improbable that within the foreseeable future there will be any rapid movement to exploit the natural resources lying beyond" the continental margins.[78]

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[71] Bellman, Address before American Bar Association National Institute on Marine Resources, Long Beach, California, June 8, 1967, at 17-18.

[72] *Ibid.*

[73] Henkin, *supra* note 38, at 30.

[74] *Ibid.*; Christy and Brooks, Shared Resources of the World Community, at 155, in Seventeenth Report of the Commission to Study the Organization of Peace (1966).

[75] NPC, for example, finds that "the oil and gas operator must have certain necessary incentives before sizeable expenditures are committed to exploration and/or research and development of deep sea systems," including "[e]xclusive rights to exploitation of a commercial discovery" and "[p]recisely specified operating rules and applicable laws enforced by an established and stable regime." NPC Interim Report, at 7.

[76] *Id.* at 9-10.

[77] *Id.* at 16-17.

[78] *Id.* at 17, 19.

This NPC position may be based upon an underestimate of the pace of technological advance as serious as that made by the framers of the Geneva Convention. NPC itself recognizes that "limited knowledge" makes it impossible to draw a "definitive seaward limit on existence of petroleum deposits."[79] On August 26, 1968–not even two months after the NPC report was adopted–the National Science Foundation announced that the *Clomar Challenger,* on an expedition sponsored by it, had drilled a hole penetrating 480 feet into the seabed under 11,753 feet of water in the Sigsbee Knolls area of the Gulf of Mexico and found a show of oil and gas.[80] Nor does NPC speak for some American mining companies which cannot afford to ignore the large, potential reserves of copper and nickel in the manganese nodules lying on the bed of the sea beyond the continental margins.

It is not helpful to point out that even if the international legal-political framework were satisfactory, economic and technological factors would presently inhibit exploration and exploitation of mineral resources in deep waters. It is also true that if technological and economic factors were favorable, the existing framework would presently deter such exploration and exploitation. Just as it takes time and planning to prepare the scientific, technological and economic bases for exploring and exploiting the mineral resources lying deep under water, it also takes time and planning to create an international legal-political framework that will be hospitable to such exploration and exploitation.[81] Indeed, conscious and appropriate law-making may actually encourage the steps necessary to build the scientific, technological and economic foundations for the desired activity, and thereby help achieve the objectives of the Marine Resources and Engineering Development Act.

NPC's recommendation to take "exclusive jurisdiction" of the mineral resources of the continental margins may at first seem attractive. The United States has the power to effectuate it and acquire permanent, exclusive access to the mineral resources of approximately 479,000 square statute miles of sea-bed and subsoil, in addition to approximately 850,000 square statute miles of continental shelf up to the 200-meter isobath.[82]

Very rich petroleum deposits are expected to be found in this vast area and the United States would make itself the sole beneficiary of their exploitation. Furthermore, some United States oil companies would rather face the known perils of the exercise of exclusive authority by coastal States around the world than the unknown perils of an international legal-political framework yet to be negotiated.

Nevertheless, the International Panel recommends that this alternative should be rejected. In view of the uncertainties that surround the existing definition of the continental shelf, the international community would regard United States action pursuant to this alternative as a "grab." We think President Johnson was opposed not only to a "race," but also to an agreement by coastal States to "grab" the sea's resources.

This alternative is unfair to the non-coastal States of the world and to the coastal States which will not find important mineral deposits on or under their continental slopes and rises.

The NPC proposal would benefit other coastal States of the world proportionately more than the United States and thus give them exclusive authority over the natural resources of immense subsea areas. In light of recent history, it is short-sighted to assume that U.S. private enterprise would be better off to deal with these coastal States for rights to develop these resources in the absence of any recognition of the interest of the international community in them.

Finally, there is the danger, which materialized in some cases as an unforeseen and undesired consequence of the Truman Proclamation of 1945, that other nations may be impelled to extend their exclusive authority until it covers not only the mineral resources of the continental margins but also the superjacent waters and the fish therein, the surface waters and the air above these waters.[83] It is not inconceivable that coastal States which will not find important mineral deposits on or under their continental margins may be particularly tempted to make such enlarged claims.

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[79] *Id.* at 5.

[80] See Ocean Industry, October 1968, Vol. 3, No. 10, p. 35.

[81] *[C]omprehensive change in international law is slow. The principal method is by multilateral convention at a multilateral conference. Such a conference is usually the final stage in an extended process that includes expert studies, the drafting of texts, the comments of governments, other preparatory measures and diplomatic activity that takes years to complete, even if no government deliberately seeks to delay.*

Henkin, *supra* note 38, at 37.

[82] These figures are based upon estimates of the United States Geological Survey. The equivalent figures in square nautical miles would be approximately 361,000 and 630,000 respectively. Around the world, the number of square nautical miles between the 200-meter and the 2,500-meter isobath is approximately equal to the number of square nautical miles of continental shelf up to the 200-meter isobath. Other coastal States of the world would thus gain proportionately more than the United States by the NPC suggestion.

Such a development would obviously be contrary to traditional United States policy to limit national claims to the sea in the interest of the maximum freedom essential to the multiple uses (including military) which the United States now makes of the oceans. Accordingly, United States security interests are best served by the narrowest possible continental shelf for purposes of mineral resources development.[84]

Others who think it unnecessary for the United States to seek a new international legal-political framework for mineral resource exploration and exploitation assume that (1) general principles of international law permit a State to acquire either (a) general sovereignty of the sea-bed and subsoil of any submarine area by way of occupation; or at least (b) "sovereign rights," i.e., permanent, exclusive access to the mineral resources of a particular submarine area which it is the first to occupy and exploit; or that (2) in any case, the United States will stand ready to protect private investment and activities in the exploration and exploitation of mineral resources in any submarine area of the world.[85] These assumptions are so dubious that it is difficult to see how any private entrepreneur would risk the large sums of money that deep ocean resource engineering and development will require on the belief that any one of them will prove to be valid.

C. Is a Wait-and-See Policy Desirable in Any Case?

It may be maintained that the uncertainties of the status quo, with all their inhibiting effects upon the attainment of American objectives regarding the use of the oceans, are still preferable to any early effort to reach new, international agreement on the framework that should govern the exploration and exploitation of the mineral resources underlying the high seas.[86] Ocean science, technology and mineral resources development are still in their early stages. Knowledge is lacking of the quantitative and qualitative distribution of the mineral resources underlying the oceans. The extent of future demand for these mineral resources is not clear. No exploitation of these mineral resources is presently taking place in deep waters and it is doubtful whether such exploitation is likely to occur soon. The characteristics of deep ocean technology and of the minerals for which there will be the greatest demand cannot be foreseen and therefore the problems of conflicting use that will arise cannot be anticipated. All this makes it premature to devise a new framework to allocate and regulate these uses.

Furthermore, delay will enable the nations of the world to enter into negotiations for a new framework on the basis of some actual operating experience and with a better understanding of the implications of the alternatives. It may then be easier to negotiate a satisfactory new framework because nations will know the costs and difficulties of exploiting the ocean's mineral resources and will be more reasonable than they are likely to be now when they are influenced by tales of the untold riches to be extracted from the deep seas.

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[83] John Craven has noted that "the trend of international agreement and unilateral legislation leads to an extension of the rights of coastal States seaward with increasingly restrictive rights in the ever widening territorial sea." Craven, Technology and the Law of the Sea, 2 The Ohio State University Mershon-Carnegie Endowment Conference on Law, Organization and Security in the Use of the Ocean, March 17-18, 1967 at 1, 34 (1967). See also, Remarks prepared and delivered by Captain L. E. Zeni, USN, The University of Rhode Island Law of the Sea Institute, June 26, 1968, at 7-9.

For the unilateral legislation following the Truman Proclamation from which Mr. Craven deduces this "trend," see Baker, Legal Aspects of the Continental Shelf and Seabed, Report No. 8, prepared for the U.S. Arms Control and Disarmament Agency (ACDA) by the Battelle Memorial Institute, ACDA/St-120, May 17, 1967; Negotiations on Continental Shelves: A Survey of Bases for Definition, Technical Inquiry No. 5, prepared for ACDA by ACTIAC, Battelle Memorial Insitute, Sept. 8, 1966.

[84] See Address of Robert A. Frosch, Assistant Secretary of the Navy for Research and Development, The Ohio State University Second Mershon-Carnegie Endowment Conference on Law, Organization and Security in the Use of the Ocean, Oct. 7, 1967, at 8; Zeni, *supra* note 83, at 8-9.

[85] See generally, Northcutt Ely, The Administration of Mineral Resources Underlying the High Seas, American Bar Association National Institute on Marine Resources, Long Beach, California, June 8, 1967.

[86] This argument, supported by the reasons that follow in the text, is advanced by the former Judge Advocate General of the Navy Rear Admiral Wilfred Hearn, The Role of the United States Navy in the Formulation of Federal Policy Regarding the Use of the Sea, American Bar Association National Institute on Marine Resources, Long Beach, California, June 8, 1967, at 19; and Burke, A Negative View of Proposals for United Nations Ownership of Ocean Mineral Resources, *id.* at II, 10-11.

Finally, it is maintained, delay will not harm the United States because its technological and financial capabilities will enable it to compete in spite of the uncertainties of the status quo.

In many respects, the panel finds these arguments persuasive, but on the whole it concludes that it would be unwise for the United States to accept them. As we pointed out in connection with similar arguments advanced by the National Petroleum Council, they underestimate the mutually reinforcing relationship that can exist between scientific, technological and economic planning, on the one hand, and legal-political framework planning, on the other.

Furthermore, unless a new framework is devised, some venturesome governments and private entrepreneurs will act in accordance with one or the other of the undesirable alternatives possible under the uncertain *status quo* and in time create *faits accomplis* that would be difficult to change, even though they adversely affected the interests of the United States and the international community. These consequences might be avoided if a wait-and-see policy were accompanied by a moratorium on exploration and exploitation beyond the 200-meter isobath, an alternative proposed by some United Nations diplomats.[87]

But it is already United States policy to lease submarine areas for mineral resources exploration and exploitation at greater and greater depths.[88]

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[87] See Marine Science Affairs 1968, at 30; 22 U.N. GAOR, Provisional Verbation Record of the 1527th Meeting of the First Committee 56 (U.N. Doc. No. A/C. 1/PV. 1527, Nov. 14, 1967.)

[88] See Charles F. Luce (Under Secretary of the Interior), The Development of Ocean Minerals and the Law of the Sea, American Bar Association National Institute on Marine Resources, Long Beach, California, June 8, 1967, at 2, 4; Frank J. Barry (then Solicitor of the Interior Department), Administration of Laws for the Exploitation of Offshore Minerals in the United States and Abroad, American Bar Association National Institute on Marine Resources, Long Beach, California, June 9, 1967, at 12, 13; Memorandum from Associate Solicitor, Division of Public Lands, to Bureau of Land Management on Seaward Limits of the Outer Continental Shelf, Nov. 29, 1967; Memorandum from Oil and Gas Supervisor, Gulf Coast Region, to Chief, Branch of Oil and Gas Operations on Seaward Limits of the Outer Continental Shelf, Nov. 7, 1967; Memorandum from Oil and Gas Supervisor, Eastern Region, to Chief, Branch of Oil and Gas Operations on Seaward Limits of the Outer Continental Shelf, Nov. 3, 1967; and Memorandum from Regional Oil and Gas Supervisor, to Chief, Branch of Oil and Gas Operations on Activities on the Outer Continental Shelf off the Pacific Coast, Nov. 2, 1967.

Except where otherwise indicated the following data are taken from the above sources.

It should be recalled, in considering these data, that the mineral resources of the seabed and subsoil underlying the territorial sea (defined for this purpose as three miles off the coasts of all states of the United States except Texas and Florida; nine miles off the coasts of Texas and Florida) were given to the coastal states of the United States by the Submerged Lands Act. 67 Stat. 29 (1953), 43 U.S.C. §§1301-1303, 1311-1315 (1964). The Outer Continental Shelf Lands Act, 67 Stat. 462, 43 U.S.C. §§1331-43 (1964), reserves to the United States the mineral resources of the seabed and subsoil of the remainder of the continental shelf.

Until the Santa Barbara oil lease auction, the Department of the Interior had granted 18 leases for exploitation of oil resources in waters near the United States but beyond 600 feet in depth. Some of these are in waters as deep as 1,800 feet or as far as 35 miles from shore. All but three have apparently been relinquished.

In bidding concluded on Feb. 6, 1968, 71 tracts (540,600 acres) of federal lands located in the Santa Barbara channel (between the California mainland and the channel islands of San Miguel, Santa Rosa, Santa Cruz and Anacapa) were leased by private industry. Bonuses totaling $602,719,261.60 were paid for 363,181 acres lying beneath waters ranging in depth from 90 to 1,800 feet. About 60 percent of the acreage was in waters more than 200 meters deep, some as deep as 1,800 feet. Eight tracts beyond the 200-meter isobath brought bids ranging from $6 million to $27 million. Ocean Industry, May 1968, at 42-43.

In addition, the Department has issued 50 geophysical and geological permits on the Pacific Coast and 14 on the East Coast in areas that are in excess of 200 meters and up to 100 miles off the coast. It has authorized 21 core holes off the West Coast, some as far as 13.8 miles from land or 1,000 feet in water depth. It has also published OCS Leasing Maps indicating an intent to assume jurisdiction over the ocean bottom as far as 100 miles off the Southern California Coast in water depths as great as 6,000 feet.

Off the East Coast, 34 core holes have been dug, some of which are 4,873 feet deep and up to 210 miles from land. On the Gulf Coast, 135 core holes have been permitted in waters beyond 600 feet, one at 4,354 feet and 177 miles from shore.

The Department has also issued six leases for the mining of phosphate rock from the ocean floor located on the Forty-mile Bank, 43 miles offshore from San Diego and 25 miles southwest of San Clemente Island, in water depths varying from 240 feet to 4,000 feet, but mostly greater than 600 feet.

The United States has threatened litigation to prevent a private group from building a private island on Cortez Bank, a rise in the ocean floor about 50 miles from San Clemente Island and 100 miles from the California mainland. The rise is only five meters deep at its shallowest point, but is separated from San Clemente Island and the mainland by ocean floor trenches as much as 4,000 to 5,000 feet deep.

Interior Deputy Solicitor Edward Weinberg wrote a letter to Brigadier General John A. B. Dilliard of the Corps of Engineers expressing the opinion that Cortez Bank was an area over which the United States had jurisdiction under the Outer Continental Shelf Lands Act and the Continental Shelf Convention. The letter went on to state that the Interior Department would regard the attempt to create the private island as a trespass and would request the Attorney General to enjoin it.

According to its Solicitor, the Department of the Interior has not decided on a line beyond which it will not lease, nor has it decided to lease as far out as anyone might suggest. "Each case," he stated, "will be considered individually, with consultation with the State and Justice Departments where appropriate."[89]

Other nations, too, have indicated an interest in exploring and exploiting mineral resources at depths greater than 200 meters.[90] If the United States limited itself to the 200-meter isobath, it is not likely that other nations would follow its example. To persist in such a limitation would slow the progress of marine science, technology and resource development and deprive the United States and its nationals of a fair opportunity to engage in exploration and exploitation of the mineral resources of the deep seas. This would be inconsistent with the objectives of the Marine Resources and Engineering Development Act, which seek to maximize the opportunity for American industry to exploit these mineral resources and preserve the role of the United States as a leader in marine science and resource development.

Thus, even a wait-and-see policy must be an active, not a do-nothing, policy if these objectives are to be attained and undesirable *faits accomplis* avoided. Such a policy would require the United States to decide now that it would not claim permanent, exclusive access to mineral resources beyond a certain depth and that it would object to any such claims by other coastal States. It would require the United States to decide whether to permit the Interior Department to lease rights to explore and exploit mineral resources beyond that depth. If Interior were to be permitted to lease such rights, the United States would need a plan to encourage activity by the lessee because the international legal-political framework eventually agreed upon might not recognize United States authority in the area in question.

In short, because of the uncertainties of the status quo, an effective wait-and-see policy would require the United States to have a clear picture of the international legal-political framework it would prefer. In that case, it might just as well take the initiative to seek that framework and thereby help to shape the future in a constructive fashion.

D. United Nations Activity Looking to a New International Legal-Political Framework

In any case, it is not realistic to assume that the United States will have the option simply to wait and see what happens under the existing framework. The United Nations is deeply immersed in the oceans and steps have been taken in various of its organs looking to the creation of a new framework for the exploration and exploitation of the mineral resources of the sea-bed and subsoil beyond the outer limits of the continental shelf. It should also be noted that under Article 13 of the Convention on the Continental Shelf, any State acceding to the Convention may request its revision at any time after five years have elapsed from the date the Convention came into effect, i.e., at any time after June 10, 1969. The United Nations General Assembly must then decide what to do about the request.

1. The Resolution on Resources of the Sea

At the 1966 United Nations General Assembly, United States initiatives resulted in the adoption of a Resolution on Resources of the Sea.[91] This Resolution requested the Secretary-General (a) "to make a survey of the present state of knowledge of the resources of the sea beyond the continental shelf, excluding fish, and of the techniques for exploiting these resources";[92] and (b) "to undertake . . . a comprehensive survey of activities in marine science and technology, including that relating to mineral resources development, undertaken by members of the United Nations family of organizations, various Member States and intergovernmental organizations concerned, as well as by universities, scientific and technological institutes and other interested organizations."

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[89] See Barry, *supra* note 88, at 13.

[90] Fourteen States other than the United States have issued permits for activity beyond the 200-meter isobath. Wilson, Oil Hunters Will Hasten Quest for Marine Reserves, 27 Offshore, No. 13, p. 43 (Dec. 1967). Australia has issued an exploration permit for an area 200 miles from its coast; Honduras and Nicaragua have licensed exploration in an area 225 miles from their coasts. Schedule of Selected Concessions Granted in Continental Shelf Areas 11 (1967).

[91] Resolution 2172, 21 U.N. GAOR, Supp. No. 16, at 32, U.N. Doc. A/6316 (Dec. 8, 1966).

[92] A similar resolution, not excluding fish, was passed by the United Nations Economic and Social Council on March 7, 1966. Resolution 1112, 40 U.N. ECOSOC, Supp. No. 1, at 3, E/4176 (1966).

In the light of these surveys, the Secretary-General was requested:

> *to formulate proposals for: (a) Ensuring the most effective arrangements for an expanded programme of international cooperation to assist in a better understanding of the marine environment through science and in the exploitation and development of marine resources, with due regard to the conservation of fish stocks; (b) Initiating and strengthening marine education and training programmes, bearing in mind the close interrelationship between marine and other sciences.*

The Secretary-General has now completed these surveys.[93] In his *Introduction and Summary,* the Secretary-General made the following significant observations:

> *. . .in view of the large expenditure and inherent risks [of operations in the ocean environment], it must be expected that would-be entrepreneurs will seek maximum safeguards for their investment, in the first instance by obtaining such exclusive rights as may be necessary to offer the prospect of a fair return. At the same time, the legitimate interests of the world community as a whole must not be jeopardized by any undesirable activities.*
>
> *All this presupposes the existence of some kind of administrative machinery with adequate authority to allocate exploration, exploitation and other rights over particular areas for specific lengths of time and possibly for specific minerals, to determine the scale of fees and royalties and the proper use of their proceeds, to ensure systematic and orderly operations by the entrepreneur and afford such protection as he may reasonably expect. The establishment of such administrative machinery and its recognition by the international community appears to be a matter of some urgency.*
>
> *Equally necessary, in the near future, is a decision at the international level on the outer limit of the continental shelf which as presently defined is so imprecise as to leave virtually open the important question of where the exclusive rights of riparian countries cease to apply.*[94]

The Secretary-General recommended that the United Nations should be given:

> *adequate responsibility for systematic collection and diffusion of information regarding economic marine mineral deposits, techniques appropriate for their development, as well as for resolving related juridical, general administrative and political issues."*[95]

At its 45th Session, August 2, 1968, the UN Economic and Social Council endorsed the reports of the Secretary-General and passed a resolution requesting the Secretary-General:

> *to follow closely new developments which may occur in fields of marine mineral resources exploration, evaluation and exploitation beyond the continental shelf and the possible implications thereof, and to report when appropriate to the Economic and Social Council.*[96]

2. The Malta Resolution

At its 22nd 1967 session, the United Nations General Assembly considered the legal status of the mineral resources of the sea-bed and subsoil beyond the outer limits of the continental shelf. The debate was provoked by Malta which, on Aug. 18, 1967, proposed the following item for the agenda:

> *Examination of the Question of the Reservation Exclusively for Peaceful Purposes of the Seabed and the Ocean Floor, and Subsoil Thereof Underlying the High Seas Beyond the Limits of Present*

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[93] Report of the U.N. Secretary-General on the Resources of the Sea, U.N. Economic and Social Council, 44th Session, Agenda Item 3(c), and 45th Session, Agenda item 12, Introduction and Summary, E/4449, 21 Feb. 1968; Part One: Mineral Resources of the Sea Beyond the Continental Shelf, E/4449/ Add. 1, 19 Feb. 1968; Part Two: Food Resources of the Sea Beyond the Continental Shelf Excluding Fish, E/4449/ Add. 2, Feb. 7, 1968; and Marine Science and Technology: Survey and Proposals, E/4487, April 24, 1968.

[94] *Id.*, Introduction and Summary, at 4-5.

[95] *Id.*, Marine Science and Technology: Survey and Proposals at 82.

[96] UN ECOSOC Resolution II, E/4584, Aug. 2, 1968.

National Jurisdiction, and the Uses of Their Resources in the Interest of Mankind.[97]

3. Creation of Ad Hoc Committee To Study the Peaceful Uses of the Seabed and Ocean Floor Beyond the Limits of National Jurisdiction

The Malta Resolution was referred to the First (Political) Committee of the General Assembly. After debate in this Committee and on the floor, the General Assembly, by a vote of 99-0 on Dec. 18, 1967, adopted a resolution sponsored by 39 countries, including the United States.[98] This Resolution recognizes that "the exploration and use of the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the (Malta) item, should be conducted in accordance with the principles and purposes of the Charter of the United Nations, in the interest of maintaining international peace and security and for the benefit of all mankind." The General Assembly, the Resolution states, is mindful "of the provisions and practice of the law of the sea relating to this question," and "of the importance of preserving the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the (Malta) item, from actions and uses which might be detrimental to the common interests of mankind."

Under the Resolution, an *ad hoc* committee of 35 nations[99] was created to prepare a study, for consideration by the General Assembly at its 23rd (1968) Session, which would include:

(a) A survey of the past and present activities of the United Nations, its agencies, and other intergovernmental bodies regarding the seabed and ocean floor;

(b) An account of the scientific, technical, economic, legal and other aspects of this (Malta) item; and

(c) An indication of practical means to promote international co-operation in the exploration, conservation and use of the seabed and the ocean floor, and the subsoil thereof, as contemplated in the title of the item, and of their resources, "having regard to the views expressed and suggestions put forward by Member States during the consideration of this item at the twenty-second session of the General Assembly."

The Resolution requested the Secretary-General to submit to the Ad Hoc Committee his report on the resources of the sea.

The debate on this Resolution revealed the wide range of views held by the 58 nations that participated. "Some countries advocated that title to the seabed be vested in the United Nations.

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[97] U.N. Doc. A/6840, Add. 2. This is the revised version of the original resolution which called for a declaration and treaty embodying its principles. See U.N. Doc. A/6695.

In its Memorandum accompanying the original proposal, Malta urged that immediate steps be taken to draft a treaty embodying the following principles:

(1) The seabed and the ocean floor, underlying the seas beyond the limits of present national jurisdiction, are not subject to national appropriation in any manner whatsoever.

(2) The exploration of the seabed and of the ocean floor, underlying the seas beyond the limits of present national jurisdiction, shall be undertaken in a manner consistent with the Principles and Purposes of the United Nations.

(3) The use of the seabed and of the ocean floor, underlying the seas beyond the limits of present national jurisdiction, and their economic exploitation shall be undertaken with the aim of safeguarding the interests of mankind. The net financial benefits derived from the use and exploitation of the seabed and of the ocean floor shall be used primarily to promote the development of poor countries.

(4) The seabed and the ocean floor, underlying the seas beyond the limits of present national jurisdiction, shall be reserved exclusively for peaceful purposes in perpetuity.

The Memorandum also expressed the view that the treaty

> *should envisage the creation of an international agency (a) to assume jurisdiction, as a trustee for all countries, over the seabed and the ocean floor, underlying the sea beyond the limits of present national jurisdiction; (b) to regulate, supervise and control all activities thereon; and (c) to ensure that the activities undertaken conform to the principles and provisions of the proposed treaty.*

It should be noted that Malta made no proposal to fix "the limits of present national jurisdiction."

[98] U.N. Doc. A/RES/2340 XXII. The Resolution was sponsored by Afghanistan, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Ceylon, Chile, Colombia, Ecuador, France, Ghana, India, Indonesia, Jamaica, Japan, Libya, Luxemburg, Madagascar, Malta, Mexico, Netherlands, Nigeria, Norway, Pakistan, Poland, Roumania, Senegal, Somalia, Sudan, Trinidad and Tobago, Tunisia, Turkey, United Arab Republic, United Kingdom, United States, Venezuela, and Yugoslavia.

[99] The following member States were appointed to the Ad Hoc Committee: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Ceylon, Chile, Czechoslavakia, Ecuador, El Salvador, France, Iceland, India, Italy, Japan, Kenya, Liberia, Libya, Malta, Norway, Pakistan, Peru, Poland, Roumania, Senegal, Somalia, Thailand, U.S.S.R., Tanzania, United Arab Republic, United Kingdom, United States, Yugoslavia. With the exception of Austria and Czechoslavakia, all of these are coastal States.

Others called for a moratorium on unilateral exploitation of seabed resources. Most countries seemed to feel there should be a freeze on claims of national sovereignty to the seabed. Some maritime nations opposed any consideration now by the Assembly."[100]

4. Position of the United States

In explaining its support of the Resolution adopted by the General Assembly,[101] Mr. Peter S. Thacher, the United States spokesman, stated that the Resolution fell short of what the United States considered to be "the most advantageous action this Assembly could take at this session," but that the United States placed "a very high priority on achieving a broad consensus on the part of this Assembly." He also made it clear that the United States did not understand the resolution to "express any views of the General Assembly with respect to any principles which may eventually be developed to govern the exploration and use of the deep ocean floor." "Any such questions regarding the future regime of the deep ocean floor," he added, "whether they involve commercial, scientific or military uses, remain to be studied and considered in the future." To remove all doubt, Mr. Thacher emphasized that the United States took the phrase in the resolution–"as contemplated in the title of the [Malta] item" to refer to "an area and environment"–"the seabed, ocean floor and subsoil thereof"–and not to exploration or use in the area and environment. The United States expressed the hope that on the basis of the work of the Ad Hoc Committee, "the next General Assembly may well wish to establish a Committee on the Oceans."

Earlier, Ambassador Arthur J. Goldberg had explained to the General Assembly's First Committee debating the Malta Resolution that the United States envisaged that the Committee on the Oceans would (a) consider all proposals placed before the General Assembly on marine questions and make recommendations on such proposals to the Assembly for action; (b) assist the General Assembly in promoting long-term international cooperation in marine science; (c) assist the General Assembly in considering questions of law, including such matters as rights of use and exploration, arms control and problems of pollution; (d) make recommendations for action by the 23rd and subsequent General Assemblies to stimulate and support international cooperation and exchange in the exploration of the ocean floor; (e) begin immediately to develop general standards and principles to guide States and their nationals in the exploration and use of the deep ocean floor; and (f) develop arms control measures as part of the evolving law of the deep ocean floor.[102]

It should be recalled that the United States has changed its position with respect to the development of "arms control measures as part of the evolving law of the deep ocean floor" and now favors submitting arms control questions to the United Nations 18-Nation Disarmament Committee.[103]

5. Work of Ad Hoc Committee

The Ad Hoc Committee met during March 1968 and set up two working groups–(a) the Technical and Economic Working Group to deal with technical and economic questions, and (b) the Legal Working Group to deal with legal questions. The Committee saw its essential functions as gathering information, clarifying issues and defining goals of possible international action.[104]

The Committee met again three times during the summer of 1968. On Aug. 30, 1968, it adopted the report which it will submit to the 23rd (1968) session of the General Assembly. With its report, the Ad Hoc Committee also presented the reports of the Economic and Technical and Legal Working Groups, and the draft resolutions and other proposals put to it. The Committee's report summarizes and briefly discusses these reports and proposals. But the Committee itself was unable to agree on a set of recommendations or proposals to submit to the General Assembly.

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[100] Marine Science Affairs 1968, at 30.

[101] U.N. General Assembly Doc. A/C 1/PV 1542.

[102] See Press Release, U.S. U.N.–182, November 8, 1967, Dept. of State Bull., Nov. 27, 1967, at 723.

[103] See Draft Resolution of United States On Preventing The Emplacement of Weapons of Mass Destruction On the Seabed and Ocean Floor, United States Mission to the United Nations, Press Release U.S. U.N.–107 (68), June 28, 1968.

[104] See U.N. General Assembly A/AC 135/SR. 1-9, March 18-27, 1968, which contains a summary of the March meetings.

In particular, the Committee pointed out that its terms of reference "did not provide for the elaboration by (it) of a scheme for the legal regulation of the status of the seabed and ocean floor and of the activities of States with regard to the seabed and ocean floor." It also stated that "it was emphasized" in committee "that the question of the elaboration of a set of principles needed further consideration and study and that at the present time this would be premature." However, the Committee also expressed its belief that "the progress so far achieved would be most useful in facilitating the attainment of final agreement on more positive action by the General Assembly at its twenty-third session."

E. Conclusion

The current concern of the United Nations General Assembly with the problems of exploring and exploiting the mineral resources underlying the high seas makes it imperative that the United States shall have a carefully formulated position to present to the United Nations. Obviously, the process of arriving at a new framework for the conduct of such exploration and exploitation will take years to complete. If nothing else is done in the interim, the difficulties and dangers of living with the uncertainties of the *status quo* will be accentuated.

It is important, therefore, to attempt to secure international agreement, at the earliest possible time, on the principles by which the nations of the world will be guided in conducting such exploration and exploitation in the period immediately ahead and on the means by which these principles may be implemented.

The panel approves the steps–which we shall shortly review–that the United States has already taken in this direction. It is also vital that these principles be consistent with an international legal-political framework that will help to attain United States objectives with regard to mineral resource exploration and exploitation in the oceans. To assure consistency, the United States must have a clear idea of what that framework shall be. Accordingly, the International Panel also recommends that the United States should take the initiative in elaborating such a framework and proposing it to the international community. If it does not, it will be forced to react to the initiatives of other nations, as was the case during the 1967 session of the United Nations General Assembly.

The International Panel would like to emphasize that the United States should institute the process of creating a new framework without assuming that it must suffice for all time. What is needed for the immediate future is a framework that will encourage mineral resource exploration and exploitation and yet be sufficiently flexible to adapt itself to advances in technology and successive stages of experience with such exploration and exploitation.

IV. A RECOMMENDED DECLARATION OF PRINCIPLES BY THE UNITED NATIONS GENERAL ASSEMBLY

The position of the United States with respect to such a declaration of principles has undergone a significant and desirable change during the course of the deliberations of the United Nations General Assembly and its Ad Hoc Committee.

In his speech on the resolution creating the Ad Hoc Committee, Ambassador Goldberg stated the fundamentals of the United States position as follows:

> *First, we believe that the prospects of rich harvest and mineral wealth both in the deep oceans and on the deep ocean floors must not be allowed to create a new form of competition among marine nations.*
>
> *Second, my nation believes that the nations of the world should take steps to assure that there will be no race among nations to grab and hold the lands under the high seas. The deep ocean floor should not be allowed to become a stage for competing claims of national sovereignty.*
>
> *Third, we must insure that the oceans and the deep ocean-bottoms remain, as they are, the legacy of all human beings and that the deep ocean floor will be open to exploration and use by all states, without discrimination.*
>
> *Fourth, my nation stands ready to join with all other nations to achieve these objectives in peace and under law.*[105]

In his Second Annual Report on Marine Resource and Engineering Development, President

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[105] Press Release, U.S./U.N.–250, Dec. 18, 1967, Dept. of State Bull., Jan. 22, 1968, at 125.

Johnson indicated that the United States would also regard as desirable early international accord on the following additional principles: (a) "International standards should be set to foster orderly exploration and use of the seabed," (b) "Activities on the seabed should be conducted with reasonable regard for the activities of other States;" (c) "Cooperative scientific research of the seabed should be encouraged together with broad dissemination of the results of scientific studies;" and (d) "Pollution and interference with the traditional freedoms of the seas should be avoided."[106]

On June 28, 1968, the United States Representative to the Legal Working Group of the Ad Hoc Committee introduced a draft resolution[107] under which the United Nations General Assembly would commend "to States for their guidance the following principles concerning the deep ocean floor":

> *1. No State may claim or exercise sovereignty or sovereign rights over any part of the deep ocean floor. There shall be no discrimination in the availability of the deep ocean floor for exploration and use by all States and their nationals in accordance with international law.*
>
> *2. There shall be established, as soon as practicable, internationally agreed arrangements governing the exploitation of resources of the deep ocean floor. These arrangements shall reflect the other Principles contained in this Statement of Principles Concerning the Deep Ocean Floor and shall include provision for:*
>
> *(a) the orderly development of resources of the deep ocean floor in a manner reflecting the interest of the international community in the development of these resources;*
>
> *(b) conditions conducive to the making of investments necessary for the exploration and exploitation of resources of the deep ocean floor;*
>
> *(c) dedication as feasible and practicable of a portion of the value of the resources recovered from the deep ocean floor to international community purposes; and*
>
> *(d) accommodation among the commercial and other uses of the deep ocean floor and marine environment.*
>
> *3. Taking into account the Geneva Convention of 1958 on the Continental Shelf, there shall be established, as soon as practicable, an internationally agreed precise boundary for the deep ocean floor–the seabed and subsoil beyond that over which coastal states may exercise sovereign rights for the purpose of exploration and exploitation of its natural resources.*
>
> *Exploitation of the natural resources of the ocean floor that occurs prior to establishment of the boundary shall be understood not to prejudice its location, regardless of whether the coastal state considers the exploitation to have occurred on its "continental shelf."*
>
> *4. States and their nationals shall conduct their activities on the deep ocean floor in accordance with international law, including the Charter of the United Nations, and in the interest of maintaining international peace and security and promoting international cooperation, scientific knowledge, and economic development.*
>
> * * *
>
> *6. In the exploration and use of the deep ocean floor, States and their nationals:*
>
> *(a) shall have reasonable regard for the interests of other states and their nationals;*
>
> *(b) shall avoid unjustifiable interference with the exercise of the freedoms of the high seas by other states and their nationals, or with the conservation of the living resources of the seas, and any interference with fundamental scientific research carried out with the intention of open publication;*
>
> *(c) shall adopt appropriate safeguards so as to minimize pollution of the seas and disturbance of the existing biological, chemical and physical processes and balances.*
>
> *Each State shall provide timely announcement and any necessary amplifying information of any marine activity or experiment planned by it or its nationals that could harmfully interfere with the activities of any other State or its nationals in the exploration and use of the deep ocean floor. A State which has reason to believe that a marine activity or experiment planned by another State or its nationals could harmfully interfere with its activities or those of its nationals in the explora-*

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[106] Marine Science Affairs 1968, at 30.

[107] Draft Resolution Containing Statement of Principles Concerning the Deep Ocean Floor, United States Mission to the United Nations, Press Release U.S. U.N–107 (68), June 28, 1968. Principle 5 deals with international scientific cooperation and will be considered in Chapter 5 of this report.

tion and use of the deep ocean floor may request consultation concerning the activity or experiment.

7. States and their nationals shall render all possible assistance to one another in the event of accident, distress or emergency arising out of activities on the deep ocean floor.

It should be noted that the United States, during the course of the debates on the resolution creating the Ad Hoc Committee, referred to the "deep ocean floor" without attempting to define it and thereby seemed prepared to accept the uncertainty surrounding the definition of the continental shelf. By contrast, the principles suggested to the Ad Hoc Committee recognize the need to eliminate this uncertainty by establishing "as soon as practicable, an internationally agreed precise boundary for the deep ocean floor."

Moreover, the United States position originally stated by Ambassador Goldberg seemed to exclude only (1) the "national lake" or "median line" approach to the existing definition of the continental shelf; and (2) the view of the general principles of international law that would permit the nation of the first "occupier" of the sea-bed of a submarine area to claim "national sovereignty" over the sea-bed of that area, i.e., the right to exclude anyone from making *any* use of the area in question without its permission. It did not exclude the claim and exercise of "sovereign rights" in the area in question, i.e., the claim of permanent, exclusive access to the mineral resources of the sea-bed and subsoil of that area. By contrast, the principles suggested to the Ad Hoc Committee state expressly that no State "may claim or exercise sovereignty *or sovereign rights* over any part of the deep ocean floor."

It should be emphasized that this principle does not imply that title to or sovereignty over the deep ocean floor is being vested in the United Nations. Nations have signed treaties disclaiming sovereignty over outer space[108] and agreeing to make no new claims, including enlargements of existing claims, in Antarctica[109] without bestowing sovereignty or title to unclaimed areas upon the United Nations or any other international agency.

Finally, the principles suggested to the Ad Hoc Committee, unlike the position earlier taken by the United States, recognize "the interest of the international community in the development of" the mineral resources of the deep ocean floor by specifically proposing the "dedication as feasible and practicable of a portion of the value of the resources recovered from the deep ocean floor to international community purposes."

On the whole, the International Panel supports the statement of principles proposed by the United States. We recommend, however, that the United States should amend its statement to propose the principle that no State should claim or exercise sovereignty or sovereign rights over any part of the sea-bed or subsoil beyond the 200-meter isobath. That would constitute a clear effort to reserve the submarine areas beyond the 200-meter isobath for future international decision. The United States statement of principles seeks to accomplish the same purpose by pronouncing that exploitation "of the natural resources of the ocean floor that occurs prior to establishment of the boundary [for the deep ocean floor] shall be understood not to prejudice its location, regardless of whether the coastal State considers the exploitation to have occurred on its 'continental shelf.' " But this principle gives no indication of what the United States—or any other coastal State—should reasonably consider to be its "continental shelf" for purposes of the Convention on the Continental Shelf. In the absence of such an indication, coastal States may be encouraged to claim wider continental shelves than would be consistent with U.S. interests and thereby influence the ultimate location of the shelf's boundary.

Nevertheless, the proposed statement of principles is an important step toward the attainment of United States objectives in the oceans. It is consistent with, and indeed points to, the new framework which the panel recommends. While its embodiment in a Declaration by the United Nations General Assembly may not be more than a recommendation and at most may bind those States which vote for it and, perhaps, those which do not dissent from it,[110] it would help greatly to "hold-the-line" in a way that would not jeopardize the new legal-political framework being negotiated.

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[108] See Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, signed at Washington, D. C. Jan. 27, 1967; entered into force for the United States, Oct. 10, 1967, T.I.A.S. No. 6347.

[109] See the Antarctic Treaty, signed at Washington, D. C. Dec. 1, 1959, entered into force for the United States, June 23, 1961, 12 U.S.T. 794, T.I.A.S. No. 4780, 402 U.N. T.S. 71.

V. OTHER STEPS TO BE TAKEN PENDING NEGOTIATION OF NEW FRAMEWORK

The principles urged upon the Ad Hoc Committee by the United States have certain consequences for domestic policy as well.

A. Leasing Beyond the 200-Meter Isobath

The United States must decide whether it will continue to lease rights to explore and exploit the mineral resources of the bed or subsoil underlying the high seas beyond the 200-meter isobath, subject to any new framework that may be adopted. We think an affirmative answer to this question is implicit in the principles stated. But we recommend that the United States should take this position explicitly. Only such a position is consistent with the objectives of the Marine Resources and Engineering Development Act of 1966.

To remove all uncertainty for American private enterprise, the United States must also take a position soon on the precise boundary it would like to see established between the "continental shelf" and the "deep ocean floor." The panel recommends that, for purposes of the Convention on the Continental Shelf, the continental shelf should be redefined so as to fix its seaward limit at the 200-meter isobath or 50 nautical miles from the baselines for measuring the breadth of the territorial sea, whichever alternative gives the coastal State the greater area of seabed and subsoil for permanent, exclusive mineral resources exploration and exploitation.

B. Guaranteeing Private Investment

If, as the United States proposed, exploitation of the mineral resources beyond the 200-meter isobath is not to prejudice the ultimate location of the boundary between the "continental shelf" and the "deep ocean floor," a dilemma confronts private enterpreneurs and all other prospective investors in marine mineral resources exploration or exploitation. To proceed with such exploration and exploitation is to run the risk that the area of operations may ultimately find itself included in the "deep ocean floor" rather than the "continental shelf" and governed by a less favorable framework than now applies under the Outer Continental Shelf Lands Act.

This risk would be obviated if any new framework exempted all exploration and exploitation occurring prior to its adoption. However, the panel thinks the United States wisely resisted suggesting this solution, because it would encourage developments that might jeopardize the possibility of reaching international agreement on a framework based on the principles enunciated by the United States.

If, to avoid the risk described, American private enterprise should decline to proceed with exploration and exploitation beyond the 200-meter isobath, United States objectives in the oceans would be thwarted.

The International Panel thinks this dilemma is not very serious and, more important, that it can be resolved. We agree with the position taken by the United States before the Ad Hoc Committee. Furthermore, under the international legal-political framework which we recommend, private enterprise will actually run very little risk by proceeding with exploration and exploitation beyond the 200-meter isobath. There is no guarantee, of course, that this recommended framework will be accepted. Accordingly, we recommend that Congress should enact legislation to compensate private enterprise for loss of investment or expenses occasioned by the fact that the international legal-political framework ultimately adopted includes as "deep ocean floor" the area in which it was previously engaged in exploration or exploitation of mineral resources.

C. Amendment of Outer Continental Shelf Lands Act

The scope of this Act is as uncertain as the existing definition of the continental shelf. It is important, however, that private entrepreneurs should know when they must seek the Government's permission to engage in exploration and exploitation of subsea minerals. It is equally important that the United States have adequate control over the evolving situation until a new framework is negotiated.

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[110] Henkin, *supra* note 38, at 531 n. 162, citing Asamoah, The Legal Significance of the Declarations of the General Assembly of the United Nations (1966).

Accordingly, the panel recommends that the Outer Continental Shelf Lands Act should be amended to require permission from the Secretary of the Interior to engage in mineral resource exploration or exploitation in any subsea area beyond the 200-meter isobath upon such terms and conditions as the Secretary deems appropriate. The amendment should make clear that this requirement is not intended to constitute a U.S. claim to exercise sovereignty or sovereign rights over any subsea area beyond the 200-meter isobath or to relinquish any claim the United States may have under the Convention on the Continental Shelf.

In deciding whether to grant permission, the Secretary of the Interior should be guided by the Secretary of State's judgment as to the foreign policy implications of the particular situation in question.

VI. A RECOMMENDED INTERNATIONAL LEGAL-POLITICAL FRAMEWORK

A. Preliminary Remarks

The panel recognizes that changes in the existing international legal-political framework must be negotiated and agreed to by the nations of the world and this fact makes it hazardous to venture specific recommendations. Nevertheless, we venture such recommendations, not because we are certain that every one of them will survive the process of international negotiation, but only by being concrete is it possible to examine critically the full implications of the kind of framework the present situation requires.

Accordingly, we should also like to stress that our major recommendations are interrelated. Rejection of any of these major recommendations would necessitate a reexamination of all.

B. Redefinition of the Continental Shelf

The redefinition of the continental shelf, for purposes of the Convention on the Continental Shelf, is an essential first step to bring about a new international legal-political framework consistent with United States objectives in the oceans. The principles proposed by the United States to the United Nations Ad Hoc Committee recognize this fact. The panel recommends that the United States, after June 10, 1969, take the additional step of requesting the revision of the Convention for the purpose of redefining the continental shelf.

It is difficult, however, to decide how the continental shelf should be redefined. If it is redefined to extend its seaward boundary materially so as to give each coastal State exclusive access to substantial mineral resources of various kinds, relative to its foreseeable needs in the coming decades, the coastal States may not be too concerned about the nature of the legal-political framework for the exploration and exploitation of the mineral resources beyond the continental shelves as thus redefined. The Interim Report of the National Petroleum Council attests to this possibility. On the other hand, it may also be true that if the coastal States find completely acceptable the legal-political framework for the exploration and exploitation of the mineral resources beyond the continental shelves, however redefined, they will not be too concerned about the redefinition of the continental shelf.

On balance, the panel concludes that the question of the redefinition of the continental shelf should not be considered apart from that of the framework for the exploration and exploitation of the mineral resources in the submarine areas beyond the continental shelf, however redefined. As a practical matter, the two questions will be intertwined in international negotiations. Furthermore, with advancing technology and increasing human needs, it would be unwise to continue to leave exploration and exploitation of any of the seas' mineral resources in a state of legal uncertainty.

It has been suggested that the continental shelf's outer limits be fixed at 550 meters, 600 meters, 1,000 meters, 2,000 meters and 2,500 meters, at 30, 50, 100, 110 and 200 nautical miles from shore, or at various combinations of depth and distance from shore. For reasons indicated, it is the panel's conclusion that the totality of American interests would best be served, for the immediate future, by a relatively narrow legal continental shelf.

Accordingly, the panel recommends that the seaward limit of each coastal State's "continental shelf" be fixed at the 200-meter isobath, or 50 nautical miles from the baselines used for measuring the breadth of its territorial sea, whichever alternative gives the coastal State the greater area for permanent, exclusive mineral resources exploration and exploitation. (This 200 meter/50 mile pairing is about as close together as pairings on worldwide averages of the depth and width of the world's geological continental shelves can reasonably be).[111]

By providing the 200 meter/50 mile alternative, the inequity of a definition in terms of depth alone will be avoided for those coastal States which either are not on a geological continental shelf, as in the Persian Gulf, or which have coasts that drop almost immediately to great depths, as is the case off the west coast of South America. While the logic of attempting to remove this "inequity" has been doubted,[112] the coastal States in question feel the inequity strongly and their claims in this respect cannot be ignored.[113]

If the same continental shelf, as redefined, is claimed by two or more States whose coasts are opposite each other, or by two or more adjacent States, the boundaries shall be determined by applying the "median-line" principles set forth in Article 6 of the Convention on the Continental Shelf. Furthermore, if the recommended redefinition should leave, between the outer limits of the continental shelves of two or more States whose coasts are opposite each other, an area so small that it should not, as a practical matter, be made subject to the recommended legal-political framework for exploration and exploitation beyond the continental shelf as redefined, the area should be divided in accordance with the "median-line" principles laid down in Article 6 of the Convention on the Continental Shelf.

Changes in sea level, eroding shore lines, and complex bottom topography can make it difficult to apply the recommended 200 meter/50 nautical mile definition of the continental shelf. For this reason, the panel recommends that the best available bathymetric surveys be used to translate this definition into geographical coordinates for each coastal State. The resulting description should be recorded with the International Registry Authority recommended below and should not be subject to change because of alterations in the coastline or the revelations of more detailed surveys.

In parts of the world, too, the 200-meter isobath traces a circuitous position. To simplify definition of the Continental Shelf, it would be desirable to adopt a system analogous to the straight baseline system used to measure the breadth of the territorial sea.

Any redefinition of the continental shelf must also give special consideration to the problems presented by islands. We have not been able to solve these problems to our satisfaction and, therefore, make no recommendations in this respect.

C. An Intermediate Zone

The panel recommends that intermediate zones should be created off the coasts of States encompassing the bed and subsoil of the deep seas, i.e., the area beyond the continental shelf as redefined, but only to the base of the continental slopes around most of the continents. Again, in order to have limits that are fixed and certain and to lessen the inequity that some coastal States will feel if a depth limit alone is used, it is recommended that the outer limits of the intermediate zone be defined in terms of the 2,500 meter isobath or 100 nautical miles from the baselines for measuring the breadth of the territorial sea, whichever alternative gives the coastal State the greater submarine area for the purposes for which the intermediate zone is created. (This 2,500 meter/100 mile pairing is about as close together as pairings on world-wide averages of the depth and width of the world's geological continental shelves and slopes can reasonably be).[114] Here too, the panel recommends that the boundaries of the intermediate zone be fixed once and for all in terms of geographical coordinates (and by use of a system analogous to that of straight baselines) and be recorded with the International Registry Authority.

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[111] The average width of the geological continental shelf is about 40 nautical miles, but it varies from 5 miles to more than 700 miles. The average edge of the shelf is at a depth of 132 meters, but shelves are known to terminate at depths less than 70 meters and greater than 600 meters. Very few, however, terminate at a depth of more than 200 meters. See Shepard, Submarine Geology (2d ed. 1963).

[112] ". . .a doctrine based on a continental shelf will obviously discriminate against those who have no shelf, as it does against those who have no coast at all. It is a discrimination of geography, and deserves no compensation any more than do other natural disadvantages." Henkin, *supra* note 38, at 21, n. 62. But granted the desire to achieve equity, Professor Henkin suggests a redefinition of the continental shelf solely in terms of distance from shore. *Id.*, at 43, n. 129. Since such a proposal may cut back "sovereign rights" possessed by some coastal States under the Convention on the Continental Shelf, we do not think it has a realistic chance of acceptance. Professor Henkin agrees with this practical appraisal. *Id.*, at 45, n. 134.

[113] There is great dissimilarity in the extent of water of less than 200 meters surrounding the continents. Europe has 0.9 million square nautical miles of depth less than 200 meters; Asia has 2.7 million, mostly in eastern seas; Africa has only 0.4 million; Australia has 0.8 million; North America has 2.0 million, mostly in the Atlantic and Arctic; South America has 0.7 million largely off Argentina; Antarctica has 0.1 million; and isolated islands have 0.4 million. See Kossina, Die Tiefer des Weltmeers (1921).

If the same intermediate zone is claimed by two or more States whose coasts are opposite each other, or by two adjacent States, the boundaries should be determined by applying the "median-line" principles set forth in Article 6 of the Convention on the Continental Shelf.

Only the coastal State or its licensees, which may or may not be its nationals, shall be authorized to explore or exploit the mineral resources of the intermediate zone. In all other respects, exploration and exploitation in the intermediate zone shall be governed by the framework recommended below for the areas of the deep sea beyond the intermediate zone. As the latter framework is explained, the full significance of the intermediate zone will be made clear.

The recommendation that only the licensees of the coastal State shall have access to the mineral resources of the intermediate zone, under the conditions specified below, is a compromise between the position, exemplified by the NPC Interim Report, that the continental shelf should be redefined to include the intermediate zone and the position that the intermediate zone should be treated in every respect like the areas of the deep sea beyond it. The compromise recognizes that the uncertainties of the present definition of the continental shelf may have raised the expectations of coastal States to the point where they may refuse to accept the recommended redefinition without the recommended intermediate zone. It also recognizes that for some time to come, exploitation of particular mineral resources of the intermediate zone may, in the language of the Truman Proclamation of 1945, be "contingent upon cooperation and protection from the shore" and that "self-protection" may compel "the coastal nation to keep close watch over activities off its shores which are of the nature necessary for the utilization of these resources."

At the same time, the compromise recognizes that the mineral resources of the intermediate zone cannot be said, in fairness and equity, to "belong" to the coastal States so that all other States–and the international community–should be entirely excluded from the benefits of their exploitation.

D. The Framework Governing the Bed of the Deep Seas and Its Subsoil (i.e., the Area Beyond the Continental Shelf as Redefined)

1. Introductory Remarks

The International Panel has carefully evaluated the following principal alternatives proposed to govern exploration and exploitation of the mineral resources of the bed of the deep seas and its subsoil:–(a) divide the mineral resources of the bed of the high seas and its subsoil among the coastal States and thereby make the whole new framework unnecessary; (b) recognize any State's claim to permanent, exclusive access to the mineral resources of particular areas of the bed of the deep seas or its subsoil which that State is the first to discover and exploit; (c) add to either of the foregoing alternatives certain "international" features to make it more acceptable to the nations of the world; (d) give the United Nations, in the name of the international community, "title" to the living resources of the sea beyond the 12-mile limit and to the mineral resources of the deep seas, in the sense that a designated United Nations agency would hold ownership rights and grant or lease them, or use them itself, and distribute the revenues derived from the exercise of its ownership rights in accordance with directives from the United Nationas General Assembly; (e) give the United Nations, in the name of the international community, "title" only to the mineral resources of the deep seas and its subsoil and only in the sense that a designated United Nations agency would have authority to prohibit all exploration and exploitation of such mineral resources without its prior permission; to auction to the highest bidder such licenses, i.e., exclusive rights to explore and exploit specified mineral resources in specified areas of the deep seas; and to use the revenues from such licensing for internationally-agreed purposes.

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[114] The average width of the geological continental slope is about 15 nautical miles, but it varies from 10 to 50 miles. The average base of the slope is at a depth which varies from 1,400 to 3,200 meters. Worldwide, about 7½ per cent of the total ocean area is of a depth less than 200 meters and another 8½ percent is from 200 meters to 2,000 meters, of which about half is deeper than 1,000 meters. For the United States, the ocean areas at a depth less than 200 meters exceed the areas at depths from 200 to 2,000 meters. See Encyclopedia of Oceanography (Fairbridge ed. 1966); Menard & Smith, Hypsometry of Ocean Basin Provinces, 71 J. of Geophysical Research 4305, 4315 (1966); and the text accompanying note 82 *supra*.

In Appendix A to this report, the panel sets forth the arguments for and against each of these alternatives. It has rejected them because no one of them satisfies the objectives which an international legal-political framework should attain in the immediate future. Nevertheless, the following recommended framework incorporates particular elements of some of these alternatives and others which have not hitherto been proposed.

It is possible that if the Convention on the Continental Shelf is reopened after June 10, 1969, a new, single Convention will be negotiated which will both redefine the "continental shelf" and provide a framework for mineral resources exploration and exploitation of the deep seas. It is also possible that two conventions may eventuate: the Convention on the Continental Shelf with a redefined "continental shelf," and a separate convention for the deep seas. Whether there should be one or two conventions does not raise a question of principle. However, the panel has recommended that the questions of redefining the "continental shelf" and agreeing upon a framework for the deep seas be considered together. It also recommends that the new international agreements, whether embodied in one or more conventions, should contain the following provisions in addition to redefining the "continental shelf" and creating an "intermediate zone."

2. An International Registry Authority

(a) All claims to explore or exploit particular mineral resources in particular areas of the deep seas shall be registered with an International Registry Authority. Only a State, or an association of States, shall be eligible to register such a claim.

Every State that is a Party to the agreement shall undertake not to engage in, or authorize, exploitation except under such a registered claim. Any State, if it wishes, will be free to engage in exploration without registering a claim therefor. But the advantages of registration, indicated below, will be sufficient to induce early registration. Greater freedom should be allowed in exploration than in exploitation in order to enable prospective exploiters to make preliminary investigations to determine whether they wish to register a claim to explore.

(b) The membership of the Registry Authority, and the manner of choosing its governing body, shall be specified in the agreement embodying the new framework. The Authority shall find its place in the family of United Nations organizations but shall be as autonomous as the World Bank. It should probably be organized on a "multiple principle" of representation, based on the technical capacity of its members, as well as their geographical distribution.

(c) The Registry Authority shall register claims with respect to specified mineral resources, e.g., oil and gas, or all minerals other than oil and gas, or all the mineral resources in a specified area of the deep seas, on a "first come, first registered" basis, subject only to the following condition. The State claimant must satisfy the Registry Authority that the individual, association, corporation or State-organization that will actually undertake the exploration or exploitation meets specified standards of technical and financial competence and willingness to perform the task.

The State Registrant shall be authorized to hold a registered claim for any business entity other than that on whose behalf the claim was originally registered, *provided that* it notifies the Registry Authority of the substitution and the substitute meets the Authority's specified standards. In any case, the entity undertaking the task may or may not be a national of the State Registrant. That will be a matter for each State to decide for itself.

But for the condition mentioned, which is necessary to prevent claim-registration from being used to "sit on" the "rights" derived therefrom, the Registry Authority will have no discretion to deny registration of any claim. In practical effect, every State will decide for itself when and where it, or its licensees, shall explore or exploit mineral resources on the bed of the deep seas or in its subsoil. However, the panel again emphasizes, if the claim pertains to an area within some coastal State's "intermediate zone," only that coastal State shall be authorized to register it. Furthermore, the coastal State may decide not to register any claim for mineral resources exploration or exploitation within its intermediate zone. No other State–or its nationals–may then enter the intermediate zone for this purpose. In this respect, the coastal State will have the same exclusive authority in the intermediate zone that it has on its continental shelf.

(d) Registration of a claim to explore for particular mineral resources, e.g., to conduct geological and geophysical operations in the search for oil and gas, in a particular area of the deep seas shall confer upon the State Registrant the exclusive right to engage in, or authorize, such exploration. However, this right shall be subject to maximum area limitations and requirements as to the minimum time within which the resource must be proved. These limitations and requirements shall be fixed by the Registry Authority in accordance with specified standards economically suitable to such exploration. Failure to comply with these conditions, which will also serve to eliminate claim-registration for the purpose of "sitting on" rights, shall subject the registration to revocation.

(e) Upon proof of discovery, the Registry Authority shall convert the registered claim to exploration into a registered claim to exploitation.

(f) Registration of a claim to exploit particular mineral resources in a particular area of the deep seas shall confer upon the State Registrant (*i*) the exclusive right to engage in, or authorize, such exploitation *for a limited number of years;* and consequently (*ii*) internationally-recognized title, or the right to confer such title, to the extracted mineral resources. States which are parties to the agreements embodying the new framework shall undertake to enact implementing national legislation protecting such titles.

The term of years for which the State Registrant shall have exclusive access to the mineral resources of the area covered by the registered claim, as well as the size of the area, shall be fixed by the Registry Authority. The area shall be large enough, and the time long enough, to enable the producer to operate economically and not wastefully and to recover his original investment as well as an adequate return thereon.

Each registered claim shall also be subject to the requirements of actual exploitation within a specified period of time and continued exploitation thereafter, unless the Registry Authority determines, on application of the State Registrant, that world market conditions make it uneconomic to do so, in which case the Authority may suspend either requirement for the time being. Failure to comply with these requirements shall subject the registration to revocation.

Registration of a claim in a coastal State's intermediate zone shall be subject to these same conditions.

(g) In areas of the deep seas in which submarine boundaries cannot presently be clearly established, the Registry Authority shall avoid the registration of contiguous claims. In any case, the principle embodied in Article 5(2) and (3) of the Convention on the Continental Shelf should be adopted to empower the Registry Authority to establish safety zones of 500 meters around the installations and other devices constructed and maintained or operated for exploration or exploitation pursuant to a registered claim. Ships of all nationalities shall be required to respect these safety zones.

(h) Registration of a claim to explore or exploit particular mineral resources in a particular area of the deep seas shall not preclude registration of a subsequent claim involving other mineral resources in the same area, if exploration or exploitation pursuant to the subsequent claim is compatible with exploration or exploitation under the first registered claim. If it is not compatible, the principle of "first come, first registered" shall control and the subsequent claim shall not be registered.

(i) If, by chance, two or more claims to explore for the same mineral resources in the same area are sought to be registered simultaneously, a more or less arbitrary choice will have to be made by the Registry Authority. This choice can be made by lot or any other method acceptable to the competing applicants for registration.

If practicable, the Registry Authority might also seek to encourage the States seeking to register the competing claims to engage in a joint venture or to share the area in question in some other way.

(j) A State Registrant shall be authorized to transfer the registered claim to any other State which is a Party to the agreements embodying the new framework.

(k) To cover the costs of the Registry Authority, every State shall be rquired to pay a specified fee for each claim to explore which it registers and an additional specified fee if and when that claim is converted into a claim to exploit. The Registry Authority shall be authorized to fix the fees and collect them from the State Registrants.

(l) Upon expiration of the period of registration of a claim to explore or exploit particular mineral resources in a particular area of the deep seas, further exploration or exploitation of such resources shall be subject to whatever international legal-political framework may be in effect at that time. The State which registered the expired claim shall not acquire, *by virtue thereof,* a vested right to continue to explore or exploit the particular mineral resources in the particular area in question, or even a preference over any other State with respect to such further exploration or exploitation.

This shall also be the case in connection with expired claims in a coastal State's intermediate zone. Of course, if the recommended framework remains in effect at the time of expiration, only the licensees of the coastal State will continue to be eligible to register claims in the intermediate zone. Whether the business entity on whose behalf the expired claim was registered will also be the business entity on whose behalf a new claim will be registered in the area covered by the expired claim will depend upon the domestic law of the coastal State.

(m) The panel has recommended above that every State that is a Party to the agreement embodying the new framework shall undertake not to engage in, or authorize, exploitation of the mineral resources of the deep seas except under a registered claim. To effectuate this requirement, it should also be provided that in any conflict between a registered and an unregistered claim, the former shall prevail and no unregistered claim shall be entitled to any of the benefits derived from registration. Thus, operations under an unregistered claim, whether conducted by licensees of States which may not sign the agreements embodying the new framework or which may not honor the undertakings they have assumed, would have to be carried on (*i*) in the face of international agreement that no State may claim title to or national sovereignty over any area of the bed of the deep seas or its subsoil, or sovereign rights (i.e., permanent, exclusive access) to the mineral resources thereof; (*ii*) without any of the limited, exclusive rights to explore and exploit provided by the new framework; and (*iii*) subject to the rights granted under a registered claim. As a result, there will be great incentive to become a party to the agreement embodying the new framework and to register claims.

3. An International Fund

(a) Every State registering a claim for exploitation shall be required to pay a portion of the value of the production, if any, into an International Fund to be expended for purposes specified in the agreements embodying the new framework. The rates of payment shall be fixed for the different minerals by the Registry Authority and shall be uniform for all States.

(b) The proceeds from these payments shall not be expended for the general purposes of the United Nations, but for such ocean-related purposes as the financing of marine scientific activity and marine resources exploration and development, particularly food-from-the-sea programs, and for aid to the developing countries through the World Bank and other international development agencies.

(c) The Registry Authority shall collect the payments from the States registering the claims and turn the proceeds over to the International Fund, but shall have nothing to do with the Fund's management.

(d) The membership of the International Fund, and the manner of choosing its governing body, shall be determined by the United Nations General Assembly.

The panel's proposal for the creation of an International Fund for the specified purposes is not just another suggestion that rich nations aid poor nations. It offers a practical way to compensate the common owners of the mineral resources of the deep seas. It is not feasible for all the nations of the world to divide the "economic rent" that should be charged for the limited, exclusive access to such mineral resources which international registration will provide. The only practical alternative is to use this economic rent for purposes that the international community agrees will promote the common welfare. No better purposes can be imagined than to combat world hunger and aid the developing nations.

Nevertheless, the panel must caution against any optimistic assumption that proceeds from the payments called for above will be so huge as to make it unnecessary, in the coming decades, for rich nations to aid the development of poor nations in any other way. The Registry Authority will also have to keep in mind that it will defeat its purposes if it fixes the rates of payment so high as to discourage exploration and exploitation of the mineral resources of the deep seas.

4. Powers and Duties of State Registrant

Each State registering a claim shall have the following powers and duties:

(a) To enact legislation to implement the new framework and, particularly, to assure that:

(i) The business entity on whose behalf the claim is registered complies with the limitations and requirements imposed by the Registry Authority.

(ii) Due notice is given of the construction and operation of installations and other devices needed for the registered exploration or exploitation activities; permanent means are maintained for giving warning of their presence; and the installations and devices are removed when abandoned.

(iii) The registered exploration or exploitation activities *(a)* do not impede, unreasonably, the laying or maintenance of submarine cables or pipelines on the seabed in question; *(b)* do not interfere with the use of recognized sea lanes essential to international navigation; or pose any unjustifiable interference with navigation generally; and *(c)* do not result in any unjustifiable interference with fishing; or in any interference with fundamental oceanographic or other scientific research carried out with the intention of open publication; or in any waste or damage to the life or property of others; or in any unjustifiable interference with any other proper use of the sea.

(iv) The business entity on whose behalf the claim is registered takes all appropriate measures to protect the living resources of the sea from harmful agents.

(v) The specified fees and payments are submitted to the Registry Authority.

(vi) Such statistics and reports respecting the registered exploration and exploitation activities as the Registry Authority may require are collected and submitted to it.

(b) To apply its civil and criminal laws to protect the exploration and exploitation activities under its registered claims, including the personnel engaged therein, and the installations and other devices necessary therefor, against piracy, theft, violence and other unlawful interference.

The State Registrant's failure to exercise these powers so as to carry out its specified obligations effectively shall subject the registration to revocation by the Registry Authority.

If an association of States is the registrant, it may name one of its member-States as its agent to discharge the powers and duties of the State Registrant set forth above, or each of the member-States may assume them.

(c) To apply any other of its domestic laws, not inconsistent with the recommended framework, to the exploration and exploitation activities under its registered claims—such as laws respecting working conditions, the production, marketing and pricing of the extracted minerals and the taxation of the income from such activities.

If an association of States is the registrant, the member-States will have to agree upon these aspects of the exploration and exploitation activities.

5. The Limited Policing Functions of the Registry Authority

The panel does not recommend that the Registry Authority be given initial policing functions. The threat of revocation of the registration by the Authority should give State Registrants sufficient incentive to discharge their obligations under the proposed framework. In addition, they will have financial inducement to do so, particularly if they are coastal States and the registered claims are in the intermediate zone.

However, since the Authority will be empowered to cancel a registration if the State Registrant fails to discharge its obligations properly, it must have the means to exercise this power fairly and with full knowledge of the facts. Accordingly, the Authority shall be authorized to

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inspect all stations, installations, equipment and other devices used in operations under a registered claim. The Authority shall not revoke any registered claim without first giving the State Registrant involved a full opportunity to be heard. Any decision to revoke a registered claim shall be subject to review by the independent arbitration agency recommended below.

6. Relations Between the United States as a State Registrant and the Business Entities on Whose Behalf It Will Register Claims

Apart from authorizing and obligating the State Registrant to enact implementing and supplementing domestic legislation of the kind indicated above, the agreements embodying the new framework will not deal with these relations. They are the domestic concern of each State, but they must be considered by the Commission in discharging its statutory mandate. New legislation will be necessary in the United States to fix these relations and to implement and supplement the new framework.

Accordingly, the panel recommends that Congress should enact legislation embodying the following policies:

(a) Any business entity, whether a United States national or not, seeking to have the United States register a claim on its behalf with the International Registry Authority shall apply to the Department of the Interior, which shall be designated as the United States agency to register such claims.

(b) In deciding whether to register the claim, the Secretary of the Interior shall apply criteria which are not inconsistent with those the International Registry Authority itself will use and shall also be guided by the State Department's judgment as to the foreign policy implications, if any, of registering the particular claim.

(c) The recommended framework does not provide any revenues for the State Registrant from mineral resources exploration or exploitation under a registered claim. The panel considered and rejected the possibility that the framework might itself provide that the coastal States and the International Fund shall share the payments of specified portions of the value of the minerals extracted from the deep seas on a basis that diminishes the share of the coastal State as the exploitation takes place farther and farther from its shores.[115] We do not think coastal States have any more equitable claim to share in the revenues from mineral resources exploitation in the deep seas than non-coastal States. All the nations of the world, under the panel's recommendations, will be compensated for their common ownership of these resources through the payments made to the International Fund.

Furthermore, each State Registrant of a claim may decide for itself whether and how it shall be compensated by the business entities on whose behalf it will register claims to explore or exploit.

(d) So far as the United States is concerned:

(i) The business entity on whose behalf a claim is registered shall pay to the United States the specified fees to cover the costs of the Registry Authority. The United States shall then remit these proceeds to the Registry Authority.

(ii) If the claim sought to be registered pertains to an area in its intermediate zone, the United States shall adopt the policies it follows in leasing mineral resources on its outer continental shelf—with some important modifications to be noted. The panel is aware that the policies of the United States with respect to leasing on the outer continental shelf are currently being reviewed by the Public Land Law Review Commission.[116] Nevertheless, its statutory mandate requires the Commission to evaluate these policies.

The recommended framework gives the United States, and every other coastal State, valuable rights in the intermediate zone—only it may register claims there—and it is entirely equitable that it should sell this right of exclusive access to the highest bidder. It is not essential, of course, that the bidding shall be in terms of fixed amounts of cash to be paid before exploitation begins—as is now the case on the outer continental shelf. It may be in terms of a percentage of profits or net return.[117]

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[115] "This suggestion, sometimes referred to as the 'revenue lines' concept, was initially outlined by George Miron of the Office of the Solicitor, United States Department of the Interior." Henkin, *supra* note 38, at 62, n. 193.

It is our understanding that Mr. Miron himself has now abandoned this proposal.

[116] Pub. L. 88-606, Sept. 19, 1964, 78 Stat. 982, 43 U.S.C. §§1391-1400 (1967). The Commission must submit its final report to the President not later than December 31, 1970.

[117] See generally, Dam, Oil and Gas Licensing and the North Sea, 8 J. Law & Econ. 51 (1965).

Furthermore, so long as a single nation has exclusive access to certain mineral resources, a bidding procedure tends to perform the function of the price system. It tends to allocate the resources to the most efficient operator and, at the same time, to eliminate the possibility that the operator will earn a return on capital that is above the competitive level. The bidding procedure will induce the competing applicants to increase their bids to the point where any such excess is eliminated and will accrue to the benefit of the United States.[118]

However, as certain minerals are sought at greater and greater depths, the costs of exploration and evaluation[119] may become so high as to deter these activities. To achieve the objectives of the Marine Resources and Engineering Development Act, the panel recommends that the Secretary of the Interior shall be authorized to apply the most suitable government policy to encourage such exploration and evaluation.

Although not aimed at locating mineral resources, the mapping and geological survey program outlined by the Panel on Basic Science and Research[120] will aid substantially in the exploration of such resources. The International Panel recommends, further, that the Secretary of the Interior shall be authorized to waive the competitive bidding procedure if he determines that this step is necessary to encourage exploration and exploitation of mineral resources in particular areas of the deep seas and is otherwise in the best interests of the United States.

In situations in which competitive bidding is employed, the United States shall register a claim to explore on behalf of the responsible qualified business entity that first applies therefor. It shall subsequently have the registered claim to explore converted into a claim to exploit on behalf of the responsible qualified business entity that bids the highest cash bonus (or percentage of profits) therefor. It may be that the entity on whose behalf the claim to explore is registered will not be the entity on whose behalf the claim to exploit will be registered. But as recommended above, the State Registrant will be authorized to substitute any responsible qualified business entity for the entity on whose behalf the claim to explore was originally registered.

In situations in which competitive bidding is not employed, the United States shall register a claim to explore on behalf of the responsible qualified business entity that first applies therefor. Upon discovery, the claim to explore shall be converted into a claim to exploit on behalf of that same entity.

(iii) If the claim sought to be registered pertains to an area of the deep seas beyond its intermediate zone, the United States shall not use competitive bidding but shall adopt the same policy of "first come, first registered," that will guide the International Registry Authority. It shall register a claim to explore on behalf of the responsible qualified business entity that first applies therefor. Upon discovery, the claim to explore shall be converted into a claim to exploit on behalf of that same entity.

Our concern here is to prevent a "flag-of-convenience" problem from arising. No such problem can arise in the intermediate zone because only the coastal State will have access to its mineral resources. But this problem would arise if the United States used competitive bidding in deep sea areas beyond the intermediate zone, to which all other nations also have access. Explorers and exploiters would then have an incentive to request other nations, which may not charge so much therefor, to register claims on their behalf. Similarly, under our recommendations, if any other State charged for registering claims beyond the intermediate zone, explorers and exploiters would have an incentive to request the United States to register claims on their behalf.

The United States might forbid its nationals—and foreign business entities controlled by them—to have any other nation register claims on their behalf. But this would establish a most undesirable precedent. We prefer to await experience with the recommended alternative of no competitive bidding.

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[118] See *id*. at 62-63.

[119] "Exploration" refers to the "geographically broad surveys leading, by progressively narrowing the search, to the location of mineral occurrences of possible economic importance." "Evaluation" refers to the "detailed investigation of mineral occurrences or deposits, in order to discover their nature, to establish the quantity and tenor of the contained economic minerals, to determine how best they may be exploited, and generally to take into account all other factors affecting their economic development." "Production" refers to "all the operations relating to extraction, beneficiation and transport of the minerals discovered." Report of the U.N. Secretary-General, Marine Science and Technology, Survey and Proposals, U.N. Economic and Social Council, Forty-fifth Session, Agenda item 12, U.N. Doc. E/4487, April 24, 1968, at 81.

[120] See Report of Panel on Basic Science.

(iv) Whether the claim sought to be registered pertains to the intermediate zone, or to an area of the deep seas beyond the intermediate zone, the United States shall not require—as it does on the outer continental shelf—that the business entity on whose behalf a claim to exploit is registered pay to it a fixed annual rent per acre or square mile or a royalty on the value of production. But the United States shall require such business entity to pay to it the portion of the value of the extracted minerals which the United States is obligated, under the recommended framework, to pay to the Registry Authority. In this way, the rights of the international community to the mineral resources of the deep seas will be recognized without unduly burdening American private enterprise.

These payments to the Authority, which the U.S. representative on the Authority will participate in fixing, may prove to be greater or less than the rents and royalties paid on the outer continental shelf. In the intermediate zone, such differences would probably be reflected in different levels of competitive bidding.

7. Equitable Distribution of Registered Claims

The panel has considered the question whether the "first come, first registered" principle, in the light of all the elements of the recommended framework, may nevertheless work inequity among nations. In answering this question, it should be recalled that any State may register a claim beyond the intermediate zone on behalf of any business entity which may or may not be its national. Under our recommendations, too, the choice of a State Registrant by a prospective explorer or exploiter is not likely to be determined by the size of the "bonus" demanded for the privilege of registration, for reasons earlier indicated. Nor will the choice be influenced by the competition of States to extend their "sovereignty" or "sovereign rights" over new areas, because registration will have neither of these consequences. Choice is likely to be influenced by estimates of which State will offer, on the one hand, the most effective protection to the exploration and exploitation activities in question and, on the other, the domestic laws making possible the most profitable operations. In some cases, these two factors may lead in opposite directions.

If experience with the recommended framework should result in a distribution of registered claims which is harmful to the interests of particular nations, the "first come, first registered" principle may have to be modified or supplemented to achieve greater equity. This might be accomplished by setting a limit on the number of claims a State may register or by agreeing upon some geographic distribution of claims which might even go so far as to fix national or regional quotas. These quotas would take into account such factors as population; domestic production, consumption and reserves of the mineral resource in question; the quantities of the mineral resource in question already extracted under claims registered by each State; and the quantities of the mineral resource sold abroad by each State.

8. Regional Cooperation

The panel recommends that the United States should encourage regional cooperation of States in mineral resources exploration and exploitation in order to promote regional economic stability and cohesiveness and narrow the growing disparity between United States technology and that of other nations. Under the recommended framework, States wishing to cooperate may form a regional association of States and have the association register the claims with the International Registry Authority.

9. Military Uses

It may be helpful to clarify the relationship between the recommended framework for the exploration and exploitation of the mineral resources of the bed of the deep seas and its subsoil and the military uses thereof. At the outset, it should be stated that the recommended framework does not subject military uses to any control or regulation; they will be governed by existing principles of international law and any arms control agreements that may be reached.

Subject to such arms control agreements, military uses may continue to be made of the bed of the deep seas and its subsoil. If such a use was intended to be covert and is uncovered in the course of mineral resources exploration or exploitation or any other use of the seabed or its subsoil, presumably it will lose its value.

If, however, a State wishes to make overt military use of the bed of the deep seas and its subsoil, it may do so if it does not unduly interfere with mineral resources exploration and exploitation under a claim registered with the International Registry Authority. Similarly, under the recommended framework, such exploration and exploitation must seek to accommodate other uses, including military uses of the seabed and its subsoil.

A difficult question may arise if the overt military use of an area of the deep seas cannot be accommodated with mineral resources exploration or exploitation of the area under a claim registered or sought to be registered with the Registry Authority. The panel recommends, in such case, that if the overt military use was prior in time, it shall prevail, but the State making such preclusive military use of the area shall pay an appropriate amount to the International Fund. If registered mineral resources exploration or exploitation was prior in time, it shall prevail, unless the State wishing to make the military use purchases the rights of the State Registrant and pays an appropriate amount to the International Fund.

10. Dispute Settlement

The panel recommends that the United States ratify the Optional Protocol Concerning the Compulsory Settlement of Disputes which was adopted by the Geneva Convention on the Law of the Sea on April 29, 1958 and which it signed. It also recommends that the Registry Authority be empowered initially to settle disputes arising under the recommended framework for the deep seas, whether they are between States or between a State and the Authority.

At the request of any party to the dispute, however, the Authority's initial decision shall be subject to review by an independent international arbitration agency possessing expertise in resolving the kinds of questions likely to arise. The members of the arbitration agency shall be appointed by the Registry Authority. The determination of the arbitration agency shall be final.

E. Conclusion

The recommended international legal-political framework for the exploration and exploitation of the mineral resources of the bed of the high seas and its subsoil is intended to meet the needs of the immediate future. It is not intended to last for all time. Accordingly, it does not foreclose the possibility that, in time, (1) a United Nations agency might be given title to the mineral resources of the deep seas; or (2) each coastal State might be given permanent, exclusive access to the mineral resources of a submarine area off its coast which is larger than the area of the "continental shelf" as redefined in accordance with our recommendation; or (3) any State might be given permanent, exclusive access to the mineral resources of the areas of the deep seas which it is the first to discover and exploit; or (4) some other alternative not now envisaged might be adopted. However, the panel's recommendations probably do foreclose two future possibilities which we think are contrary to American objectives in the oceans: first, that the coastal States might divide the mineral resources of the deep seas among themselves; and second, that a State might secure recognition of a claim to national sovereignty over areas of the bed of the deep seas, i.e., a claim to exclude any use of the areas without its prior permission.

For the immediate future, the panel concludes, the recommended framework and accompanying national policies will help to achieve American objectives in the oceans. They will encourage scientific and technological efforts and the other major capital investments needed for exploration and exploitation of the mineral resources of the bed of the deep seas and its subsoil, by creating international machinery for the international recognition of claims to exclusive access to such mineral resources in large enough areas for long enough periods of time to make operations profitable. They will give private enterprise in the United States fair opportunities to share in such exploration and exploitation.

While it is true that the recommended framework may not, by itself, prevent uneconomic exploitation of marine mineral resources requiring high ratios of fixed costs to direct operating costs, only an international monopoly will do so. We reject the latter alternative as a greater evil for the immediate future.

The recommended framework will minimize international conflict. While the "first come, first registered" principle governing the International Registry Authority may stimulate a "race" among nations to register claims to the mineral resources of the deep seas, the recommended framework greatly tempers the nature of this race. Most important, it imposes time limits on registered claims, upon the expiration of which further exploration or exploitation of the mineral resources in the area of the expired claim will be subject to whatever legal-political framework may then be in effect.

Through the recommended International Fund, the poor and developing nations of the world will share the benefits of exploration and exploitation of the mineral resources of the deep seas.

The recommended framework will not result in undue interference with the use of the bed of the deep seas, its subsoil, its superjacent or surface waters or the air above them, for purposes other than exploration and exploitation of mineral resources. The State which registers a claim with the Registry Authority will not thereby acquire the "sovereign rights" of a coastal State over its continental shelf. This will be so even if it is a coastal State registering a claim in its intermediate zone. In either case, State Registrants will have no greater rights than those accorded them under the new framework. The new framework alone will be the source of the coastal State's rights in the intermediate zone. Thus, for example, scientific inquiry concerning the bed of the intermediate zone and undertaken there will not require the prior consent of any coastal State.

Whether a registered claim pertains to its intermediate zone or the areas beyond, the coastal State's right of exclusive access to the mineral resources thereunder will be limited. In either case, it will have to comply with all the conditions imposed by the Registry Authority to implement the new framework. International agencies will be given a significant, but limited, role in the enterprise of exploring and exploiting the mineral resources of the deep seas. Under no other alternative framework suggested will the exploring or exploiting State—or the international agencies involved—have less justification to interfere with other uses of the bed of the deep seas, its subsoil, its superjacent or surface waters, or the air above them.

Finally, the recommended framework can be changed in the light of unfolding experience, subject only to the time-limited claims already registered. On the whole, it is a necessary, first step to accomplish President Johnson's objective of assuring that the "wealth of the ocean floor must be freed for the benefit of all people."

Chapter 4 An International Legal-Political Framework for Exploiting the Living Resources of the High Seas

I. OBJECTIVES OF FRAMEWORK

Any framework for exploring the living resources of the oceans must be judged by the extent to which it achieves the following objectives:

a. It must encourage the development of the vast food reserves of the sea at the lowest possible cost in order "to help end the tragic cycles of famine and despair."

b. It must promote the orderly and economically efficient exploitation of these living resources, with adequate regard for their conservation.

c. It must give the United States and its nationals a fair chance to engage in the exploitation of these resources and make it possible to rehabilitate our commercial fisheries.

d. It must otherwise promote national security and welfare by not interfering unduly with uses of the sea for purposes other than the exploitation of its living resources.

e. It must not provoke international conflict but should contribute positively to international order, welfare and equity.

f. It must be consistent with foreign policy objectives of the United States.

Judged by these standards, the panel concludes that the existing framework is seriously deficient.

II. EXISTING FRAMEWORK

Each coastal State, unless limited by treaty, has permanent, exclusive access to the living resources found in its internal or territorial waters. While the freedom of fishing is one of the specified freedoms of the high seas, it is beclouded by the lack of agreement with respect to the breadth of the territorial sea and by the extravagant claims made by some States with respect to its breadth and that of the exclusive fisheries zone. The United States claims permanent, exclusive access to the living resources of the seas up to 12 miles from the baselines from which the breadth of the territorial sea is measured.

The freedom of fishing is also limited by bilateral and multilateral treaties and agreements and restricted by the coastal State's recognized right of exclusive access to the living, sedentary species on the continental shelf.

Appendix B to the report describes the principal international treaties and other agreements relating to fisheries to which the United States is a party.

III. EVALUATION OF EXISTING FRAMEWORK

A. The Fishery Conventions

1. United States Stake in Fishery Conventions to Which It Is a Party

The value of the total United States catch of fish and shellfish in 1967 was $438.3 million.[1] It is difficult to estimate the value of the United States fishermen's catch in areas governed by international fishery conventions to which the United States is a party. But there is agreement that it accounts for a very appreciable portion of the value of the total United States catch and is growing in importance. Moreover, the fishery conventions also affect United States companies operating under foreign flags in areas covered by the conventions, as well as imports from these areas in which United States companies have no interest.[2]

2. Objectives of Fishery Conventions

The dominant purpose of practically all the fishery conventions is to conserve the living resources of the sea. This purpose is variously stated as the attainment of the "maximum sustained catches year after year," "maximum sustained yield," "maximum sustainable productivity," "greatest harvest year after year." The Geneva Convention on Fishing and Conservation of the Living Resources of the High Seas states its objective as the attainment of the "optimum sustainable yield" of the living resources primarily as food for human consumption.

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[1] Fisheries in the U.S., 1967, at 3. (U.S. Department of the Interior, 1968).

[2] Seventy-one percent of the United States domestic supply of fishery products was imported in 1967. *Id.* at xx.

To give food usage a preferred status is unsound economically. For example, only a tiny fraction of the product of the Peruvian achovetta fishery is consumed directly. But the fishery provides inexpensive, high grade fish meal, oil and other by-products which have been of great value to the Peruvian economy as a whole. Apart from this restriction, which is contained in no other fishery convention, the objective sought by the conventions is a biological result which has been concisely summarized by Professor Crutchfield as follows:

> *The key variables determining production possibilities from a fish population can be grouped under four headings: rate of entry into the "fishable" age (recruitment); growth rates of individual fish; natural mortality (from disease, old age, and nonhuman predators); and fishing mortality. In the absence of human intervention, any marine population tends toward a maximum aggregate weight, or biomass, at which net increments to stock from recruitment and growth are exactly offset by decrements from natural mortality. Thus, at zero and at maximum population the instantaneous rate of change in the weight of the fishery population is zero. At intermediate levels, the aggregate weight of the stock, in the absence of other disturbances, will tend to rise toward its maximum value, and the instantaneous rate of change in weight will be positive.*
>
> *Assuming for the moment that recruitment and growth rates are independent of population size, these relationships can be translated into a simple physical production function. As fishing effort (expressed in terms of standard units) is increased from zero level, sustainable yield–that is, the catch equal to the instantaneous rate of change in the biomass in the absence of fishing by man–increases at a decreasing rate while the number and average size of fish will decline continuously. If the selectivity of the gear with respect to fish of different sizes is held constant, the sustainable yield will peak at some level of fishing effort. Further increases in fishing effort will produce an absolute decline in sustained physical yield. The common sense of this is apparent. Assuming a recruitment rate independent of population and a sigmoid growth function, fishing by man would yield a larger net physical product as long as the marginal reduction in weight losses from natural mortality is greater than the marginal rate loss resulting from capture of individual fish before they achieve maximum weight.*[3]

The biological concept of maximum sustainable physical yield has been criticized essentially on the ground that "the management of fisheries is intended for the benefit of man not fish, therefore, the effect of management upon fish stocks cannot be regarded as beneficial per se."[4] Indeed, unless the end products of the fishery are worth more in money than the cost of producing them, why have a fishery at all? Physical yield becomes important only if the value of the fish is assumed. For example, if part of the capital and labor now employed in the salmon fishery were diverted to catching flounders and dogfish, the physical output, in weight, of fish, could probably be expanded considerably. Obviously, it would make no sense to do this–but only because it would reduce the value of the catch to consumers and producers. It is also impossible to adhere strictly to a biological concept in any case in which two or more ecologically interdependent species are being exploited. Of necessity, the conservation objective must then be stated in terms of a maximum sustainable composite yield producing the greatest market value.

In every case, however, economists would implement the conservation objective of fishery management with the objective of maximizing the net economic return (total revenues minus total costs, including a minimum necessary profit to the vessel owner) from the fishery.[5] More fish can be taken by pushing fishing effort beyond that point, but since costs will then increase steadily while revenues will increase at a declining rate, the additional fish will not be worth what it costs to produce them. In other words, from an economic point of view, the proper output is that at which the additional cost of the last units produced is just offset by their additional value.

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[3] Crutchfield, The Marine Fisheries: A Problem in International Cooperation, 54 Amer. Econ. Rev. 207, 209-10 (1964). Crutchfield recognizes that:

the assumption that recruitment is independent of population obviously cannot be of completely general validity. For anadromous fish such as salmon the relationship is critical. Nature is so prolific in her production of fertilized eggs, however, that the case in which the number of fish surviving to catchable size is independent of the total biomass over relevant ranges is the rule rather than the exception. The other assumptions are less tenable. Growth rates are almost certain to be density dependent as are some types of natural mortality and the production possibilities implicit in the foregoing analysis are not necessarily reversible. As the size of the desired stock is reduced through commercial fishing, permanent shifts in predator-prey relations and in relative numbers of competing food users may occur. Moreover, large and frequent shifts in parameters are inevitable in the ecological setting of the sea. Id. at 210.

[4] Burkenroad, Some Principles of Marine Fishery Biology, Publications of the Institute of Marine Fishery Biology, Vol. 2, No. 1, University of Texas, 1951.

Furthermore, because the high seas fishery is a common property resource, in the sense that no fisherman has exclusive access to it so that he can keep other fishermen from sharing in its exploitation, any situation in which profits are earned, i.e., total revenues exceed total costs, will induce additional fishermen to enter the fishery or encourage additional fishing effort on the part of those already in the industry. This will take place until total revenues and total costs are equal. Additional effort will then impose losses on some fishermen who will eventually be forced out of the fishery.

Under these circumstances, no individual fishing unit "can reap the benefit of 'investment' in future supplies," and "has no incentive to restrict fishing effort in the current period to that which will maximize either physical or economic yield over time." Any attempt to "conserve" by one fisherman or group of fishermen simply increases the take of others. "The more competitive the industry involved, the more destructive the race to catch fish before others can take them."[6] The result often is an industry that is overcapitalized, i.e. with excess, unused capacity in fishing gear and men, relative to what is required to catch the maximum sustainable yield. Total costs incurred by all those exploiting a fishery may then actually exceed their total revenues and total production may even be less than could be obtained with a lesser investment of effort. It is not only possible but normal for such excess capacity to develop quickly and to persist over long periods of time, because of the traditional immobility of labor in the fisheries and the related ability to maintain capital equipment at little or no real cost. It is no accident that the most valuable fish are often harvested by fishermen with the lowest incomes.

A number of unpleasant corollaries follow from this analysis. Starting from an equillibrium point at or beyond maximum sustainable yield, if market demand for the end product increases, the final result will be a higher price, higher real costs and a lower catch. Similarly, technological improvements in fishing, processing, or marketing which lower costs of production, will eventually reduce output and raise prices to consumers.

The biological concept of maximum sustainable yield has also been criticized from another point of view.[7] The concept assumes that there is an inherent public interest in maintaining the fish population at a relatively fixed level over time. Accordingly, the biologist seeks a management plan which will maximize the ultimate recovery from the population. This is the essential meaning of maximum sustainable yield. But if the objective is to maximize net economic return, it may be sensible to exploit the fish population at a rate which exceeds the maximum sustainable yield for some time because the social benefits of such excess production during a "critical" period may exceed the social costs of a lower ultimate recovery.[8]

The maximization of net economic return also requires that a given output be produced at the lowest possible cost, i.e., with the least amount of fishing effort. The existing framework may be criticized because it fails to encourage use of the minimum necessary number of fishing units with the most efficient fishing methods and gear.

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[5] See, for example, Scott, The Economic Theory of a Common Property Resource: The Fishery, 62 J. Pol. Econ. 124 (1954); Crutchfield, Management of the North Pacific Fisheries: Economic Objectives and Issues, 43 Wash. L. Rev. 283 (1967); Crutchfield, The Fisheries: Problems in Resource Management (1965); Crutchfield and Zellner, Economic Aspects of the Pacific Halibut Fishery, Fishery Industrial Research, Vol. I, No. 1, pp. 14-15 (1962); Christy and Scott, Common Wealth in Ocean Fisheries (1965); Scott, The Fishery: The Objectives of Sole Ownership, 66 J. Pol. Econ. 116 (1955); Turvey, Optimization and Sub-optimization in Fishery Regulation, 54 Amer. Econ. Rev. 64 (1964); and The Economics of Fisheries, (Turvey and Wiseman eds., FAO, 1957).

[6] A Note on Economic Aspects of Fishery Management, (herein-after cited as Economic Aspects of Fishery Management). FAO Fisheries Circular No. 27, at 3 (1966). The Circular was produced by the Fishery Economics and Development Branch of the Department of Fisheries, FAO, based on a report prepared by Professor Crutchfield of a meeting of biologists and economists held in Rome, Sept. 27-28, 1965. Of course, the fishery conventions seek to limit fishing effort so that *physical* yield over time will be maximized.

[7] This point of view is presented by Victor Lewis Arnold, Common Property Natural Resources: Notes on Structural and Behavioral Variables Within Alternative Frameworks (1968) (Unpublished paper).

[8] The "optimum sustainable yield" objective of the Geneva Convention on Fishing and the Conservation of the Living Resources of the High Seas is not intended to adopt these social and economic considerations as criteria for fishery management.

3. Administrative Powers

a. Conservation Measures Employed The fishery conventions generally seek to attain their conservation objectives by regulations affecting (*i*) the minimum age and size of recruits to the fish population that may be caught–principally, measures governing gear selectivity, the prohibition of fishing in nursery areas and seasonal closures; and (*ii*) fishing mortality, including limitations upon the areas in which and the time when fishing may be conducted, the catching power of gear, and the overall catch.[9]

In addition, a variety of national catch quota systems are in use by the United States and Canada in the salmon fishery of the Fraser River system; by the United States, Japan and the Soviet Union in the agreements relating to King crab; and, in effect, by the United States, Soviet Union, Canada and Japan in the conservation of North Pacific fur seals. There are also various informal agreements fixing national catch quotas to which the United States is not a party–among the Soviet Union, Japan, and Norway in the regulation of Antarctic whaling, between Japan and the government of mainland China and among Japan, North Korea and South Korea.

(i.) Regulations Affecting Minimum Age and Size of Recruits Measures involving mesh size, fish size limits and the prohibition of fishing in nursery areas are intended to allow fish to grow to larger size before capture and thereby to produce an addition to aggregate weight greater than the decrements from increased losses to disease, old age, and predators. If they attain this conservation objective, these measures are also economically efficient because they produce a net addition to sustainable rates of physical output by restrictions that normally result in lower rather than higher costs of operation, *provided that* "the net addition to economic yield is greater than the going rate of interest, a condition probably fulfilled in many heavily exploited demersal fisheries."[10]

However, if these measures succeed, they will increase the profitability of the fishery and therefore intensify fishing effort, with the result that part of all of the potential increase in net economic return will be dissipated in excessive capital and labor inputs.[11]

(ii.) Regulations Affecting Fishing Mortality Closed fishing periods will have little or no effect on fishing mortality except through their impact on economic costs. If, for example, the fish are available more or less continuously and if storage and freezing costs are very low, fishing for relatively high-valued species will simply be intensified during the open period. In most cases, time closures operate to increase total costs for any given quantity taken, and thus induce a reduction in fishing effort. It is also possible that closed fishing periods, in cases where fish migrate on a regular pattern, become area closures for some of the fleet, and raise the time and distance of travel for others. In either case the operative effect on fishing mortality is through increased costs of production.[12]

If fish are not equally available throughout the year, or if weather conditions make fishing effort more hazardous or more costly during the open season, the desired reduction in mortality can be achieved, but only at the expense of additional cost per unit of catch.

"In the case of anadromous and some pelagic species, however, properly timed closed fishing periods can be a highly effective and flexible device."[13] But again, to the extent this device succeeds in its conservation objectives, it will encourage more fishing effort than is actually required and produce an uneconomic result.[14]

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[9] The classification is that of Economic Aspects of Fishery Management, at 4.

[10] *Id.* at 5. In most marine fisheries, however, "size limits are an ineffective protective measure, since the mortality of undersized fish returned to the water is very high." *Ibid.* This measure is justified primarily as a "useful complement to selectivity controls to ensure greater compliance." *Ibid.* The prohibition of fishing in nursery areas also complements other measures to restrict capture of immature fish. *Ibid.*

[11] *Ibid.*

[12] *Ibid.*

[13] *Ibid.*

[14] *Id.* at 6.

This has occured in the Puget Sound salmon fishery where the success of the conservation program produced such an influx of boats and gear that only two or three days fishing per week can be allowed and it is estimated that no more than half the gear now in use could harvest the catch, at a saving of perhaps 40 percent of the gross value of landings.[15] In addition, the "lengthening of in-season closures reduces the flow of information to the regulatory commissions and leads inevitably to unbalanced harvesting of the different races that make up the exploited stock," thereby reducing the total sustained physical yield and adding to aggregate fishing and management costs.[16]

Area closures are subject to similar objection from an economic point of view because "given seasonal variations in the availability of fish", they "frequently become merely limitations on fishing time."[17] "If fish migrate freely over an entire fishing area, with the same size composition of the population throughout, area closures would be completely ineffective except as they reduce efficiency by forcing the fleet to incur higher costs to reach open areas."[18]

The prohibition of specific types of fishing gear and appliances may be beneficial to the extent that it prevents the infliction of losses on others (through excessively destructive action) or exerts a desired selectivity effect. It may also be a necessary supplement to mesh size regulation. But, in general, restricting the use of specific types of fishing gear seems always to drift into regulation by deliberate imposition of inefficiency on the fleets involved. There "can be no rational defense of a technique that maximizes the inputs required to produce any given output, which is the essence of gear restriction, in its manifold forms, as a control device."[19] Furthermore, "the extraordinarily bad record of compliance and enforcement [of conservation regulations] in the Alaska salmon fishery can be traced in large part to the resentment provoked by the economic absurdity of many of the efficiency-reducing measures that have been adopted over time."[20]

The overall catch limit "is by all odds the simplest and most direct way of controlling fishing mortality."[21] "In analyzing its economic effects, however, it becomes evident that the quota device is a complex technique, operating primarily as a limitation on fishing time, with secondary effects on area distribution of fishing effort, and–in some cases–on the numbers and type of vessels and gear employed."[22] Again, if a total catch limit succeeds in attaining its conservation objective, it will induce increased fishing effort. Under these circumstances, no single nation or fleet has any incentive to decrease its fishing effort because it has no assurance that every other nation or fleet will do likewise. Each nation or fleet, therefore, seeks to gain the biggest share of the increase in fish population and the potential net economic gain is dissipated.

The regulatory commission usually reacts to the increasing fishing effort by shortening the fishing season. For example, the Pacific Halibut Commission succeeded in restoring the halibut yield and was able to increase the total catch limit by about 25 percent over a period of about 20 years. Yet this induced an increase of nearly 300 percent in the number of vessels participating in the fishery.[23] As a result, the season, originally about nine months in length, was shortened drastically, at one time, to 24 days on one major fishing ground.[24]

There are many undesirable effects of such a shortened fishing season. Boats and men must find off-season employment and this invariably involves some loss of labor time and idleness of equipment that cannot be recovered. To get the largest possible share of a fixed aggregate catch, each fishing unit seeks to remain on the fishing ground as long as possible during the open season. This leads it to use the nearest ports on all but the final trip, producing a geographic pattern of landings that will result in the lowest total cost for any given catch only by sheer accident.[25]

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[15] *Ibid.*

[16] *Ibid.*

[17] *Ibid.*

[18] *Ibid.*

[19] *Ibid.*

[20] *Ibid.*

[21] *Ibid.*

[22] *Ibid.*

[23] *Ibid.*

[24] Templeman and Gulland, Review of Possible Conservation Actions for the ICNAF Area, Commissioners Doc. No. 12, Fifteenth Annual Meeting of ICNAF, June 1965.

[25] Economic Aspects of Fishery Management, at 7.

Processing capacity must be enlarged to handle the induced peaks in production and it remains under-utilized for much of the year. Higher storage costs are incurred and the risks involved in holding inventory over longer periods of time, borne initially by fish processors and marketers, ultimately result in lower prices to fishermen. Instead of enjoying a steady flow of fresh halibut, the consumer receives it in less desirable frozen form for much of the year.[26]

Finally, in some cases, exemplified by the earlier attempts to regulate Antarctic whaling, a total catch limit, by itself, may force the participants in the fishery competing for it to fix the limit at a level higher than that called for by sound conservation practice. (A quota somewhat less than that required by sound conservation practice has been agreed upon recently, but only after severe damage had been inflicted on the whale stocks).

From an economic point of view, the ideal regulations affecting mortality would include a total catch quota designed to maximize net economic return and restrictions on entry that would limit the number of operating units, each of maximum efficiency, to the minimum required to take the quota on a full time basis.[27]

b. The Abstention Doctrine The International Convention on the High Seas Fisheries of the North Pacific Ocean is the only fishery convention in which State parties agree to abstain from fishing for specified stocks of fish (salmon, halibut and herring) in specified areas of the high seas.[28] The International North Pacific Fisheries Commission is authorized to recommend, after study, that the abstention principle shall no longer apply to a specified stock of fish in a specified area or that it shall apply to additional stocks of fish in additional areas.

There is no completely satisfactory answer to the problems raised by the abstention doctrine. It has been strongly advocated by the United States on the ground that the nation through whose efforts and money a high seas fishery has been developed, and through whose regulatory measures (and consequent restraints upon its fishermen) the fishery is being conserved, should have priority in its exploitation. If the stocks are being fully utilized, that Nation should even have the right to exclude others who made no similar contribution to the fishery.

Varied objections were voiced against the abstention doctrine when it was proposed by the United States and rejected during the deliberations that preceded the adoption of the Convention on Fishing and Conservation of the Living Resources of the Sea.[29] It was maintained that the doctrine discriminated against the developing nations and in favor of the developed nations; it conflicted with the principle of freedom of the seas; it was subject to abuse by nations which might claim incorrectly that certain fisheries had been developed to their maximum sustainable yield by their efforts alone; and it was based upon inadequate study of the relevant biological, economic, social and political factors.

It is most unlikely that the abstention doctrine will prove to be acceptable as a means of excluding new entrants from fisheries already being exploited fully. The controversies engendered by the application of the doctrine in the North Pacific Ocean attest to this conclusion. The United States has a strong case here. It has restrained its own fishermen for more than 50 years to rebuild the salmon runs; and it has spent hundreds of millions of dollars for pollution control, fish ladders, fish hatcheries, artificial propagation and research to protect and enhance the salmon population.

The Japanese do not deny that the United States should have certain special rights with respect to the salmon but argue that these rights should be commensurate with the United States investment and apply only to the stock of fish affected by its investment. They point out that none of this investment has been made in Alaskan rivers and streams, that they exploit only Alaskan spawned salmon on the high seas and that about 95 percent of the weight of this fish is gained while they are beyond the territorial waters of the United States. They argue, too, that they have by now borne part of the expense of salmon conservation by acceding to the abstention doctrine for more than 10 years and should be entitled to some share of the catch. They deny that because a coastal State prevents its fishermen from depleting a resource, it has an equitable claim to exclusive access to the resource, particularly when multinational conservation efforts are possible. Japan also maintains that evidence based upon scientific research does not indicate that more extensive exploitation of the salmon will not provide a substantial increase in yield that can be sustained year after year and therefore that the basic condition for the application of abstention under the Convention is not satisfied.

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[26] *Ibid.* See also, Crutchfield and Zellner, note 5, *supra;* and Dodyk, Report on the International Law of Ocean Fisheries 20 (Prepared for National Council on Marine Resources and Engineering Development, 1967).

[27] Economic Aspects of Fishery Management, at 8.

[28] See Appendix B. For general discussion of the abstention doctrine, see Yamamoto, The Abstention Principle and its Relation to the Evolving International Law of the Sea, 43 Wash. L. Rev. 45 (1967); Herrington, Comments on the Principle of Abstention, Papers Presented at the International Technical Conference on Conservation of the Living Resources of the Sea, Rome 1955, U.N. Doc. A/Conf. 10/7, at 344-49; Van Cleve, The Economic and Scientific Basis of the Principle of Abstention, Law of the Sea, Official Record, U.N. Doc. A/Conf. 13/3, at 47-63.

[29] See generally, McDougal and Burke, The Public Order of the Oceans 956-60 (1962); Johnston, The International Law of Fisheries 275-82, 289-97 (1965). A good deal of the following discussion is based upon these sources, as well as the sources cited in note 28 *supra.*

Finally, the abstention doctrine in the North Pacific may be jeopardized by the entry into the Convention area of the Soviet Union, South Korea and other nations which are not parties to the Convention. The Convention itself recognizes the inapplicability of the abstention doctrine to "any stock of fish which is harvested in greater part by a country or countries not party to the Convention." While the Soviet Union so far has demonstrated a tacit willingness to leave alone the salmon and halibut fisheries from which the Japanese have agreed to abstain, it is free to change its position at any time. Moreover, South Korea is participating in the salmon fisheries of the North Pacific. The resulting unfairness to the Japanese is apparent.

The impasse which has been reached in connection with Japanese proposals to eliminate the abstention doctrine reveals the difficulties that will be encountered in any attempt to replace it. However, it also reveals that abstention is not a viable principle in the long run. In many regions of the world, nations with distant-water fishing fleets are rapidly expanding their activities into some of the world's most valuable fisheries contiguous to the coasts of countries which need the protein but lack the technical and financial capacity to participate in these fisheries. These countries fear that, by the time they have attained the necessary competence and capital, the abstention doctrine may bar them from these fisheries or be used as justification for admitting them on unfavorable terms. It should not be surprising, therefore, that these developing countries oppose the doctrine—as do all newcomers to a particular fishery—as one that seeks to preserve an inequitable status quo. It should be pointed out, too, that in time the United States itself may be a new entrant into the fisheries of many areas of the world.

As aquaculture progresses and capital and labor are invested to cultivate particular living resources of the sea artificially, there may be a place for the abstention doctrine to protect the investor's right of exclusive access to these resources.

c. Limited Power of Fishery Commissions The fishery commissions—the administrative agencies created by the fishery conventions to carry out their objectives—generally have only the power to make recommendations which must be accepted by all the States Parties to become effective. The Agreement between the United States and Canada respecting the sockeye and pink salmon fisheries is an exception to this general rule. Commission action to adjust emergency orders or the closing or opening of fishing periods and areas during any fishing season is not subject to approval of the two Governments. To become effective, however, such action must be voted for by at least two of the three Commissioners of each Government. The fact that the two governments need not formally approve such action is probably not significant because enforcement responsibilities under the agreement in question are vested in the national fishery agency of Canada and the Department of Fisheries of the State of Washington. Neither government is likely to enforce a Commission action of which it disapproves and the Commission will know, informally, whether its action will be approved and enforced before it takes it.

The Convention on Fishing and Conservation of the Living Resources of the Sea attempts to overcome the difficulties that stem from requiring unanimous approval of the States parties to an international fishery convention before a conservation regulation can become effective. In the first place, it forces consideration of the need for conservation of a fish stock if only one State participating in the fishery, or a non-participating coastal State, or, under some circumstances, a non-coastal non-participating State, insists upon it. If agreement does not result from such consideration, the Convention authorizes any such State to invoke the dispute-settlement machinery it establishes. Furthermore, the coastal State is authorized unilaterally to adopt non-discriminatory conservation measures which are binding upon foreign fishermen, subject to the same dispute-settlement machinery. Decisions of the special commission created to settle the disputes are binding on the States concerned.

The Convention provides the means to bolster all existing fishery conventions. Its procedure could be employed to prevent depletion of certain fish stocks which are not subject to conservation regulations until such time as a new fishery convention is negotiated. It could also be invoked if a State Party to an existing fishery convention refuses to accept a commission recommendation or a State which is not a Party enters the convention area and disregards the existing conservation regulations. The coastal State could then act unilaterally and could probably take effective action to enforce its conservation regulations.

Unfortunately, however, the Convention has not been accepted by all the important fishing States of the world and it is very doubtful that it has been accepted by a sufficient number of them to have become part of international law. It is difficult to say, therefore, that a coastal State is clearly justified to invoke the Convention as the source of its authority to impose its conservation measures upon a State which is not a party to the Convention. The refusal of any important fishing State to cooperate in a multinational conservation effort, although it participates in the fishery affected by that effort, remains a threat to the conservation and economic objectives of international fisheries management.

4. Administrative Organization and Budget

Table 1[30] sets forth the estimated expenditures for fiscal year 1969 of the fishery commissions to which the United States is a party, together with the United States contribution to these expenditures.

In all, these commissions are expected to spend approximately $3,313,700 in fiscal 1969. Of this total, the United States will contribute $2,064,000, of which $1,031,000 will go to the work of the Great Lakes Fisheries Commission. In

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[30] Based upon data supplied by National Council on Marine Resources and Engineering Development.

Table 1

Fishery Convention	Total Estimated Expenditures Fiscal 1969	U.S. Contribution, Fiscal 1969	
	(Dollars)	(Dollars)	Per cent of Total
Inter-American Tropical Tuna . . .	$ 435,000[1]	$ 416,000	96.0[1]
Northwest Atlantic Fisheries	100,000	7,000	7.0
High Seas Fisheries of North Pacific Ocean	72,000	24,000	33.3
Preservation of Halibut Fishery of the Northern Pacific Ocean and Bering Sea	412,000	206,000	50.0
Sockeye Salmon Fishery of the Fraser River System	754,000	377,000	50.0
Great Lakes Fisheries	1,516,000[1]	1,031,000	68.0[1]
Conservation of North Pacific Fur Seals	8,000	2,000	25.0
Regulation of Whaling	16,700[1]	1,000	6.0[1]
TOTAL	$3,313,700	$2,064,000	

[1] Approximate.

addition, the United States spends money on research of interest to fishery commissions which do not have their own scientific staffs. Thus, it is estimated that in fiscal 1969, the United States will spend $850,000 for purposes of ICNAF; $1,500,000 for purposes of INPFC; $260,000 for purposes of the Fur Seals Convention; and $65,000 for purposes of the Whaling Convention.

Including these latter expenditures of $2,675,000, the total expenditures of the United States for purposes of the fishery conventions to which it adheres will amount to $4,739,000.

Table 2[31] sets forth the contributions of the United States for fiscal 1969 to other international organizations for marine programs, totaling $4,869,071. These international organizations will spend a total of approximately $14 million for marine programs in fiscal 1969. Not all of this, of course, will be spent on fisheries. However calculated, it is likely that the total sums spent on fisheries by all the listed international organizations, including the fishery conventions to which the United States is, and those to which it is not, a party, will amount to no more than a small fraction of one percent of the $10 billion which we estimate was the value of the total catch from the world's fisheries in 1968.

The severe budgetary limits under which some of the fishery commissions operate reflect the deliberate choice of their member governments to rely on their own fishery research agencies and not to supply the Commissions with full-time scientific, technical and economic staffs to accomplish their objectives. While impressive scientific work has been accomplished in this manner, there is always the danger that scientific opinion may tend to serve, or be suspected of serving, national interests on issues of great moment. We have pointed out, for example, that the Japanese disagree, on scientific grounds, that the abstention doctrine should be applied to salmon in the North

Table 2

International Organization	U.S. Contribution, Fiscal 1969	
	(Dollars)	Per cent of Total
UN Food and Agriculture Organization (Fisheries Department)		
Regular budget	$1,025,082	31.90
UN Development Program	3,400,000	40.00
Total	$4,425,082	
UN Educational, Scientific and Cultural Organization (oceanography, including Intergovernmental Oceanographic Commission)		
Regular budget	$ 117,200	29.94
UN Development Program	113,680	40.00
Total	$ 230,880	
Intergovernmental Maritime Consultative Organization		
Regular budget	$ 119,026	11.39
UN Development Program	79,379	40.00
Total	$ 198,405	
International Hydrographic Bureau	$ 14,702	7.94
GRAND TOTAL	$4,869,071	

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[31] *Ibid.*

Pacific Ocean. The other States Parties to the Convention hold contrary scientific opinions.

Equally serious, many States Parties to fishery conventions or to the regional fishery councils of the United Nations' Food and Agriculture Organization lack the necessary scientific personnel or the resources to employ them. They are unable, therefore, to do the research required to establish the scientific basis for the conservation work of the fishery commission or council in question. Yet the commission or council has no staff of its own to do the work.

The important contribution which an independent staff can make to a fishery commission is demonstrated by the experience of the International Pacific Halibut Commission, the International Pacific Salmon Fisheries Commission and the Inter-American Tropical Tuna Commission, each of which is adequately financed for this purpose. However, the distant-water fishing nations may not be eager to emulate the example of the latter Commission and pay most of the cost of supporting an independent and neutral staff for an international commission to which the coastal non-contributing nations belong and have an equal voice and vote.[32] On the other hand, the latter nations will have no confidence in any organization in which they do not have an equal voice and vote.

5. Enforcement

The problem of enforcing the conservation measures agreed upon by the States parties to a fishery convention is aggravated by the fact that not all the nations which participate in the fishery in question are parties to the Convention. For example, at least three non-member countries now participate in the fisheries of the Northwest Atlantic,[33] and the Soviet Union and South Korea have entered the convention area of the North Pacific.

Other difficulties abound. No Convention has adopted a system of international enforcement which, at the least, entrusts the task of investigation to the fishery commission itself and provides it with the means to do the job. When the International Convention for the Regulation of Whaling was amended in 1963 to authorize the International Whaling Commission to adopt regulations fixing "methods of inspection," it was expected that the Commission would establish an international corps of neutral observers, responsible to and paid by the Commission and that one such observer, not a national of the country of registration, would be assigned by the Commission to each factory ship on a whaling expedition.[34] But no such international inspection system was inaugurated and the agreement to establish it has expired.

The enforcement provision of ICNAF is the weakest type. Under it, the States Parties agree "to take such action as may be necessary to make effective the provisions of this Convention and to implement any proposals" which all the interested States have accepted. This leaves it to each State Party to enforce the provisions of the Convention, and any Commission regulations implementing them, against its own nationals and fishing vessels. While a system of international enforcement has been recommended for ICNAF, it has not yet been instituted.

The Conventions involving the North Pacific Fur Seals, High Seas Fisheries of the North Pacific Ocean, Pacific Salmon Fisheries and Pacific Halibut contain stronger enforcement provisions. They generally provide that authorized officials of any State Party may board, search and seize the vessel of any other State Party which they have reasonable grounds to believe has violated the provisions of the applicable Convention or Commission regulations. However, they must deliver the seized vessel and the arrested crew to the authorized officials of the State Party to which the offending vessel and persons belong, and only that State Party may try the alleged offense and impose penalties.

Under the Convention on the High Seas Fisheries of the North Pacific Ocean, furthermore, the States Parties which engage in the fisheries are obligated to carry out severally or jointly the conservation measures which they have agreed to take. They are also required to report on enforcement conditions periodically, through the Commission, to the abstaining Party and to give the abstaining Party an opportunity to observe the conduct of enforcement.

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[32] See Chapman, The Theory and Practice of International Fisheries Commissions and Bodies 35, 39, Paper Presented to Symposium on International Fishery Problems, Gulf and Caribbean Fisheries Institute, San Juan, Puerto Rico, Nov. 15, 1967.

[33] Report of the U.N. Secretary General, Marine Science and Technology: Survey and Proposals, Annex XII, at 18 (1968).

[34] Agreement Concerning International Observer Scheme for Factory Ships Engaged in Pelagic Whaling in the Antarctic, Oct. 28, 1963, 15th Report of International Whaling Commission, at 23.

Under the enforcement procedures of the existing fishery conventions, the inducement of any State Party to comply with the Convention's provisions and the commission's implementing regulations is considerable weakened by doubts as to the enforcement policy of the other States Parties.

In the United States, the Coast Guard is entrusted with the task of enforcing the fishery conventions to which the United States is a party. It is generally agreed that the Coast Guard does not have enough vessels to perform this task adequately.

On the whole, however, it may be that the panel has exaggerated the seriousness of the enforcement problem. Once the nations adherring to a fishery convention agree to adopt conservation measures of importance, it is to the advantage of each to comply. Nevertheless, stronger enforcement provisions might reduce mutual suspicions of non-compliance which encourage fishermen of all nations to disregard regulations whenever they think they can do so with impunity.

6. Limited Coverage

To achieve their conservation objectives, it is essential that the conservation measures adopted under fishery conventions shall be applicable in all the waters where the resource in question is to be found. Many of the existing Conventions do not provide this necessary coverage. Often, for example, they exclude the territorial seas from their coverage. The International Convention for the Conservation of Atlantic Tunas specifically includes the territorial seas and it may reflect the current trend of international thought on the question.

It should be noted in this connection that the 1958 United Nations Conference on the Law of the Sea adopted a resolution recommending to the coastal States that,

> *in the cases where a stock or stocks of fish or other living marine resources inhabit both the fishing areas under their jurisdiction and areas of the adjacent high seas, they should cooperate with such international conservation organizations as may be responsible for the development and application of conservation measures in the adjacent high seas, in the adoption and enforcement, as far as practicable, of the necessary conservation measures on fishing areas under their jurisdiction.*[35]

The coverage of the fishery conventions is inadequate in another crucial way. Taken together, they apply to only a small part of the actual and an even smaller part of the potential catch from the world's fisheries. At present, too, no international organization has been explicitly entrusted with the task of taking a world-wide view and making recommendations that will result in the creation of a world-wide system of regional fishery conventions able to anticipate difficulties and to assure the conserving and economically efficient utilization of the living resources of the high seas.

B. Expanding Claims of Exclusive Access to Fisheries

Varying claims with respect to the breadth of the territorial sea and the exclusive fisheries zone invite international disputes and threaten international conflict. As of Jan. 1, 1968, for example, Argentina, Ecuador, El Salvador and Panama claimed territorial seas of 200 miles; Guinea, a territorial sea of 130 miles. Chile, Peru and Nicaragua claimed exclusive fisheries zones of 200 miles; India, an exclusive fisheries zone of 100 miles and Korea, of from 20 to 200 miles. Korea, Nicaragua and Pakistan claimed sovereignty over the superjacent waters of their continental shelves.

The list of acrimonious international disputes resulting from these expanding claims is long indeed. Some of the most important have involved the United Kingdom and Iceland; Soviet Union and Japan; the United States and Chile; Ecuador and Peru; Chile and Peru; Thailand and Cambodia; Thailand and Burma; South Korea and Japan; Japan and Indonesia; Japan and Australia; Japan and New Zealand; Mexico and Guatemala; Cuba and Argentina; Soviet Union and Argentina;

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[35] Resolution on Cooperation in Conservation Measures, U.N. Doc. A/Conf. 13/L. 56, in Geneva Conference Records II, at 144 (1958).

Sweden and Norway; France and Brazil; South Africa and Southwest Africa. We shall deal here only with the dispute that most concerns the United States.

The unilateral reactions of Chile, Ecuador and Peru to the Truman Proclamations of 1945 culminated in the Declaration of Santiago, Aug. 18, 1952, in which the three countries asserted "as a principle of their international maritime policy that each of them possesses sole sovereignty and jurisdiction over the areas of the sea adjacent to the coast of its own country and extending not less than two hundred nautical miles from the said coast."[36] The United States refused to recognize this principle and was willing to have the California-based distant-water tuna fleet continue to fish for tuna within the 200 mile zone.

As a consequence, United States fishing vessels within this zone began to be seized, their catches confiscated and the owners fined.[37] In response, the Fishermen's Protective Act was passed in 1954 to reimburse the vessel owners for fines they are forced to pay to governments seizing their vessels on the basis of claims not recognized by the United States.[38] The Act further provides that the United States shall have a claim against the seizing governments for the amounts of reimbursement.

From the time the Act became effective through 1967, 75 United States fishing vessels have been seized and fines totalling $489,470 imposed upon their owners. However, only $332,702 worth of claims for reimbursement of such fines have been filed.[39] Since 1961, 50 percent of the vessels in the United States tuna fleet have either been chased, seized, harassed or shot at.[40] The State Department has not succeeded in recovering any part of the moneys paid to the seizing governments.

In 1968, the Act was amended significantly.[41] It now entitles United States vessel owners to reimbursement for any license fees, registration fees, or other direct charges, in addition to fines, they must pay to secure the prompt release of their seized vessels and arrested crews. It is estimated that this amendment will cost $120,000 to $170,000 a year.[42]

Furthermore, the Act now authorizes a temporary, four-year voluntary insurance program under which the Secretary of the Interior will guarantee reimbursement for certain additional losses. The vessel owner will be reimbursed for the destruction of or damage to the vessel, its fishing gear or other equipment, directly resulting from the seizure. The owner and crew of the vessel will be reimbursed for (1) the market value of fish caught before the seizure and confiscated or spoiled during the period of detention, and (2) 50 percent of the potential income lost because fishing time was interrupted by the seizure and detention.

Vessel owners participating in the insurance program will be required to pay the expenses of its administration and at least one-third of its cost, which is estimated at $506,668 for the four-year period.[43]

Finally, the Act requires the Secretary of State to withhold from any funds programmed under the Foreign Assistance Act to any country which seizes a United States fishing vessel and fails to satisfy the United States claim resulting therefrom an amount equal to the unpaid claim.

Not only does the existing situation exacerbate general relations between the United States and the South American countries involved to the detriment of other important objectives they share. It also discourages the development of the vast food reserves of the sea. For example, the South American countries seizing United States tuna vessels take relatively small quantities of tuna. They are principally concerned to protect the anchovetta fishery off their coasts. Yet there is no evidence that tuna fishing cannot proceed with adequate regard for the conservation of the anchovetta fishery. It is clear that withdrawal of the United States fleet from the fisheries to which the South American countries claim exclusive access would curtail the productive use of the ocean's living resources without benefiting these countries in any way.

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[36] Declaracion Sobre Zona Maritima, Art. II, Art. XIV, U.N. Legislative Series, Laws and Regulations on the Regime of the Territorial Sea, U.N. Doc. No. St/Leg./Ser. B 16, Treaty No. 20, at 724 (1957).

[37] For a list of the seizures through June 1963, see American Society of International Law, International Legal Materials 61-62 (Jan. 1964).

[38] 68 Stat. 883 (1954); 22 U.S.C. §§1972-75.

[39] H. Rep. No. 1566, 90th Cong., 2d Sess. (1968), 10 U.S. Code Cong. & Adm. News 3839, 3843 (Sept. 20, 1968); Testimony of Ambassador Donald McKernan, Hearings Before Senate Commerce Committee on S. 2269, 90th Cong., 1st Sess. 69 (1967). $120,966.90 was paid to Ecuador; $114,800.00 to Mexico; $44,000.00 to Honduras; $22,500.00 to Panama; $22,128.00 to Peru; and $8,277.90 to Columbia.

[40] *Ibid.*

[41] P.L. 90-482, 82 Stat. 729, Aug. 12, 1968. The Act is now to be referred to as the "Fisherman's Protective Act of 1967."

[42] H. Rep. No. 1566, 10 U.S. Code Cong. & Adm. News 3839, 3848 (Sept. 20, 1968).

[43] *Ibid.*

The unwarranted claims of Peru and Chile to a 200 mile exclusive fisheries zone have also impaired conservation objectives in whaling. These countries permit no other nation to engage in whaling within their 200 mile zones, yet overfish migratory sperm whales passing through the zones.[44]

IV. RECOMMENDATIONS

A. Introductory Remarks

The International Panel has carefully evaluated and rejected the following principal alternatives proposed to govern exploitation of the living resources of the high seas: (1) give each coastal State permanent, exclusive access to the living resources of the waters superjacent to its continental shelf; (2) give the United Nations, in the name of the international community, title to the living resources of the high seas beyond the 12-mile limit so that it may either operate the high seas fisheries itself or auction to the highest bidders exclusive rights to exploit specified stocks of fish or specified areas of the high seas. In Appendix C to this report, the panel sets forth the arguments for and against each of these alternatives.

The situation with respect to the exploitation of the living resources of the high seas differs materially from that respecting the exploration and exploitation of the mineral resources underlying the high seas. Existing principles of international law and the existing network of international treaties and agreements governing the exploitation of the living resources of the high seas are not beset by the major uncertainties surrounding the Convention on the Continental Shelf and the general principles of international law applicable to mineral resource exploration and exploitation beyond the continental shelf.

These uncertainties, it will be recalled, led the panel to conclude that a new international legal-political framework governing mineral resource exploration and exploitation is necessary if these activities are to be encouraged in a manner consistent with the totality of United States objectives in the oceans. However, the panel concludes that United States objectives regarding the living resources of the high seas can be best attained by improving and extending the existing treaty network, in the development of which the United States has participated for more than 50 years. Our recommendations for such extension and improvement are set forth below.

B. National Catch Quotas for the North Atlantic Cod and Haddock Fisheries

1. Basic Recommendation

In the panel's judgment, the legal-political framework for the exploitation of certain international fisheries in which the United States is greatly interested must make it possible for all the participating nations to conduct profitable operations. To this end, we conclude that the fixing of national catch quotas is one promising alternative in certain important fishing areas. We do not urge that national catch quotas should be instituted immediately in every international fishery; this method of enabling the intensity of fishing effort to be controlled should first be attempted where it is most likely to succeed and its effects should be assessed before it is more widely used. The cod and haddock fisheries of the Northwest Atlantic are ripe for such an attempt. Vessels, or fleets of vessels, however, operate in the Northeast Atlantic (NEAFC area)[45] as well as in the Northwest Atlantic (ICNAF area). Because the adoption of national catch quotas for the ICNAF area alone would increase fishing pressure upon the NEAFC area (which faces an even graver situation than the ICNAF area) and nullify any potential economic gain from national catch quotas in the ICNAF area for such vessels, the quota system proposed would have to embrace the cod and haddock fisheries of the entire North Atlantic.[46]

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[44] Chapman, *supra* note 32, at 21.

[45] The Northeast Atlantic Fisheries Convention (NEAFC), covering the Northeast Atlantic area from the Barents Sea to the Strait of Gibralter, but excluding the Baltic Sea, came into force June 1963. The Convention was signed in 1959 by Belgium, Denmark, France, Federal Republic of Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom and the Soviet Union. Its predecessor (1946) Convention for the Regulation of the Meshes of Fishing Nets and Size Limits of Fish was more limited in area and in the kinds of regulatory measures it could take. NEAFC may not only fix the minimum size of meshes and prohibit the taking of undersized fish, it may also regulate fishing gear and appliances and seek to improve the stock by artificial propagation or the transplantation of young fish.

A Commission was established to take the necessary conservation measures. It uses ICES as its primary source of scientific information.

Since 1945, fishing intensity for the major groundfish species in the North Atlantic (especially for cod and haddock) has increased greatly, but the cod and haddock yields from each of the main fishing areas have failed to increase at the same rate.[47] Indeed, at the high level of fishing intensity reached during the period 1962-65, the fishing mortality rate exceeded the maximum sustainable catch.[48] A reduction in total fishing effort of 30-40 percent in the case of some stocks, and 10-20 percent in the case of others, would sustain the catch over the long term and perhaps even increase it.[49]

The position of the United States in the fisheries in question is particularly serious. In 1965, after a particularly strong year-class of two-year old haddock entered the fishery, the United States catch increased only by about 10 percent to 57,000 metric tons. However, total landings of haddock from subarea 5 increased by 123 percent to 154,700 thousand tons, due mainly to heavy fishing by the Soviet fleet which took 81.9 thousand tons of haddock from subarea 5 in 1965 and 48.4 thousand tons in 1966. The rapid harvesting of the 1963 year class that resulted from such heavy fishing was especially unfortunate because the following year-classes have been very poor. The Soviet fleet shifted effort to other stocks when haddock abundance declined, but the United States trawler fleet, because of its limited mobility, has suffered declining catches.[50]

If total effort in the North Atlantic cod and haddock fisheries is reduced 10-20 percent, it is estimated that aggregate annual savings of $50 to $100 million can be realized by all participants, with additional economic benefits to be derived from improved size composition of the catch.[51] The maximum sustainable catch of Georges Bank haddock can be taken with a sharply reduced fishing effort that, in the long run, would increase the average catch per unit of effort by about 50 percent over the 1963-64 level.[52] Yet a study by OECD indicates that fishing effort on the North Atlantic cod and haddock stocks may increase by as much as 15-30 percent by 1970, and probably result in a decrease in the total catch, as well as a reduction of the catch per unit of effort considerably below the 1963-65 level.[53]

The nations participating in the fisheries in the ICNAF area are open to the idea of a system of national catch quotas for the cod and haddock fisheries. In addition, their Commission is highly respected and can call upon a competent and generally cooperative group of scientists and economists to make the system work.

The idea of national catch quotas was first suggested to ICNAF in 1965 in a report by the Chairman of its Research and Statistics Committee and the Chairman of its Assessment Subcommittee.[54] This suggestion was discussed at ICNAF's June 1965 meeting. It was again very carefully considered in a note by the United Kingdom Commissioners presented to the June 1966 meeting of ICNAF.[55] At this meeting, ICNAF established a working group to assess its conservation measures from both the biological and economic points of view. The Report of the Working Group, presented to the June 1967 meeting of ICNAF, strongly endorsed a national catch quota system.[56] In response to this Report, ICNAF set up a Standing Committee on Regulatory Measures to study the economic and administrative aspects of the problem. The Standing Committee met early in 1968, again during the June 1968 ICNAF meeting, and it is continuing its studies.[57] The 1968 ICNAF meeting did not devote much time to this problem, but asked its Standing Committee to meet again in January 1969.[58]

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[46] Report of the Working Group on Joint Biological and Economic Assessment of Conservation Actions, at 2, ICNAF Comm. Doc. 67/19, Annual Meeting, June 1967. (hereinafter referred to as Report of the Working Group). The Working Group was established by ICNAF with participation by FAO, NEAFC and OECD. To cover all the cod and haddock fisheries of the North Atlantic would require inclusion of the entire ICNAF Area plus Region 1 of the NEAFC Area.

[47] *Id.* at 2.

[48] *Id.* at 3.

[49] *Ibid.*

[50] Information supplied by Department of State.

[51] Report of the Working Group, *supra* note 42, at 4.

[52] *Id.*, Appendix I, at 3.

[53] *Id.* at 5.

[54] See note 24 *supra.*

[55] Note by the United Kingdom Commissioners on the Regulation of Fishing Effort, ICNAF Comm. Doc. 66-17 (1966).

[56] Note 46 *supra.* Presentation in the text is based entirely upon this and the other ICNAF documents cited above.

At the 1968 annual meeting, the United States proposed the establishment of a national catch quota system as an appropriate solution of the critical problem facing ICNAF.[59]

Accordingly, the panel recommends that the United States seek agreement in ICNAF to collaborate with NEAFC in fixing a single annual overall catch limit–expressed in terms of live (round fresh) weight–for the cod and haddock fisheries of the North Atlantic, including the whole ICNAF area and Region 1 of the NEAFC area (East Greenland, Iceland, and the Northeast Arctic). This single overall catch limit should, in turn, be divided into annual national catch quotas. Each participating nation should be assigned a single quota covering both cod and haddock.

The overall catch limit would have to be adjusted regularly to take account of such factors as year–class fluctuations of the stocks, recovery of the stocks due to conservation measures and errors in setting prior limits.

Every participating nation should be authorized to transfer all or part of its quota to any other nation.

The Convention for the Northwest Atlantic Fisheries will have to be amended to authorize the Commission to take the recommended measures which are not now within the province of its authority.

2. Is the Recommendation Feasible?

The overall catch limit would be designed to maintain the maximum sustainable yield of the cod and haddock fisheries in the areas in question year after year. The statistics now collected by ICNAF and by ICES for NEAFC are expressed in terms of live (round fresh) weight. A majority of the ICNAF Working Group on Joint Biological and Economic Assessment of Conservation Actions concluded that although "it is desirable to have much better knowledge of the state of the stocks and of year-class fluctuations,. . . . enough information is available to permit meaningful estimates of annual overall catch quotas being made."[60] United States scientists now make accurate forecasts of Georges Bank haddock stock two years in advance.[61]

The allocation of national catch quotas is not a problem of either biology, economics, law or logic and it is difficult to formulate principles on which such allocation should be based. Obviously, it will have to take account of the relative shares of the nations participating in the fisheries during some base period, but it would be unrealistic to expect that past percentages can simply be frozen or even reduced uniformly. The fisheries in question have not witnessed a stable pattern of past activity by all participants. The Soviet Union has been expanding its operations rapidly in the last two decades, and Canada, freed of previous shackles on the use of efficient trawlers, feels competent to expand in order to take what it regards as its proper share. These nations, and several others, are likely to press hard for larger quotas than could be derived from historical participation or, alternatively, to delay the proposed quota system until relative positions to their liking are securely established.

Clearly then, factors other than historical participation will have to be considered. These factors will have to include the position of coastal fishermen with no easy access to alternative fishing grounds, as well as the claims of new entrants into the fisheries, whether new members of ICNAF or non-member countries. In short, the allocation of national catch quotas will have to be negotiated. While the difficulty of securing international agreement on this matter should not be underestimated, there is reason for optimism. The situation in the North Atlantic fisheries is such that each participating nation, and particularly the larger fishing nations, will be able to see, within four to five years, that it will be better off, or at least as well off, with the proposed quota system than without it.[62]

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[57] See Report of the First Meeting of the Standing Committee on Regulatory Measures, London, 30 Jan.–1 Feb. 1968, ICNAF Comm. Doc. 68/6.

[58] Information supplied by Department of State.

[59] *Ibid.*

[60] Report of the Working Group, *supra* note 46, at 7. Commenting on this matter in 1967, ICNAF's Research and Statistics Committee stated:

Comprehensive data on the abundance of prerecruit age-groups are needed to permit the adjustment of quotas. . . A review of the data currently being collected in national research programs indicated that these data are available for one or more years prior to the age of recruitment for the haddock stocks and for some of the important cod stocks in the ICNAF area, although it was recognized that in the event of a catch quota system being introduced in this area, increased research effort would have to be devoted to the estimation of pre-recruit year-class strength. ICNAF Redbook 1967, Pt. 1, at 13.

[61] Information supplied by Department of State.

The negotiation of national catch quotas, then, is not an impossible task if each nation realistically compares the catch quota proposed for it with the absolute catch it is likely to realize (and the cost of obtaining it) in the absence of the recommended quota system, rather than with what it would like to have. Our confidence that nations will take this realistic view is based upon the conviction that the probable alternative to the proposed system will clearly be disastrous for all participants.

This confidence is buttressed by the experience of the United States and Canada under the International Pacific Salmon Fisheries Convention, where an equal division of the catch, based on no discernible logic, has proved acceptable and workable simply because the alternative was too unpleasant to contemplate. It is not shaken by the experience in Antarctic whaling. The difficulty there was not with the informally-negotiated national catch quotas but with the total catch quotas that were set too high. The nations participating in Antarctic whaling came to see time and again that they would be better off with than without national catch quotas.

Finally, there is no reason why the bargaining over the allocation of national quotas should be confined to the North Atlantic fisheries alone or, for that matter, to fishery matters alone. The range of mutual concessions that might be made to achieve agreement on quotas is broad indeed, and the wider the range of possible trade-offs the greater the possibility of reaching agreement.

3. Is the Recommendation Enforceable?

The ICNAF Working Group concluded that national catch quotas did not present insuperable problems of enforcement. Most countries participating in the fisheries in question keep a continuous record of catches by species from different parts of the areas involved. These statistics, of course, are based on what the operators report on their return to port. Once national catch quotas are in effect, these operators will have an incentive to make inaccurate reports as to the amount of fish they caught and where they caught them. To give every participating nation confidence that the quotas are being observed, the panel recommends that a system of international inspection be instituted. An international corps of neutral inspectors, responsible to and paid by ICNAF, should be created. One such inspector should be stationed at each port of landing and he should not belong to the same nation as the fishing fleet he will be assigned to inspect. This inspection effort might be evaded if landings are sought to be made at other than the usual ports, but this is not a likely eventuality because it probably would be uneconomic to do so and it could be easily discovered.

The problems facing the inspector would be manageable. For cod and haddock landed as wet or whole frozen fish, factors for conversion to live weight are available and landed weight is easily ascertainable.[63] Determining the area of origin presents some difficulty. Cod and haddock are landed from areas in the North Atlantic outside the areas in question (principally from the Baltic, the North Sea and west of the British Isles), but the vessels fishing in these outside areas are generally different from those fishing in the areas in question.[64] The same vessels may also fish at Faroes and Iceland or at Faroes and in the North Sea, but cod from Faroes can be identified easily on the market.[65]

Factory trawlers, handling processed (filleted and frozen) fish present greater problems of establishing the species, the live weight, and the area of fishing, though such vessels are most unlikely to catch cod and haddock outside the areas in question. The Working Group did not think these problems were insuperable.[66]

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[62] It should be recalled that under the recent agreement between the Soviet Union and the United States on Fishery Operations in the Western Mid-Atlantic Ocean, both countries accepted the quota principle by agreeing not to increase their fish catch in the waters in question above the 1967 level.

[63] Report of Working Group, *supra* note 46, at 7.

[64] *Ibid.*

[65] *Ibid.*

Relevant data are already available to determine the live weight and the species of fish used for fish meal and to distinguish between fish meal made of whole fish and that made of the residue of processed fish.[67] However, there is no way to check up on the quantity of fish below marketable size which is discarded at sea. Though the Working Group recognized the desirability of including discarded fish in any catch quota, because the removal of these small fish, which have a high rate of mortality when returned to the sea, has a greater adverse effect upon the future stock than the capture of the same weight of larger fish, the group recommended against inclusion because of the insuperable enforcement problem.[68]

Finally, to provide an incentive to comply, deviations by any nation from its catch quota for one year should be taken into consideration in fixing its quota for the next year. Thus, the succeeding quota should be reduced by an amount equal to 110 percent of any excess or 50 percent of any shortfall.[69] Furthermore, any nation which exceeds its quota in any year should be required to pay to all the other participating nations an amount equal to the average market value of the stock overfished by that nation during that year.

4. Is It the Best Way To Limit Fishing Effort?

The fixing of national catch quotas does not of itself guarantee that each nation participating in the fishery will enjoy the economic advantages to be gained from reducing fishing effort. That depends upon whether each nation curtails its fishing effort and the manner in which it does so. If it does not curtail its effort by restricting the number of fishing units to the minimum required to take its quota on a full-time basis, it will dissipate its potential gains. Thus, for example, the ICNAF Working Group's study of the United States operations on Georges Bank haddock revealed that if the number of fishing days *per vessel* is reduced by 30 percent, leaving unchanged the number of vessels and manpower devoted to the fishery, only very small long-term benefit would be achieved by catch quotas and short-term losses would be inflicted on both vessel owner and crew. If on the other hand, the input of capital and labor is adjusted to the reduced number of fishing days to allow full utilization of the remaining fishing capacity, an immediate and substantial improvement of the economic situation is certain and in the long run, as indicated earlier, this industry would become highly remunerative.[70]

It may also be true that unless each nation participating in the fishery rationalizes the fishing effort it devotes to catching its quota, the whole quota system may be jeopardized. Under the best of conditions, national catch quotas for all the cod and haddock fisheries of the North Atlantic will not insure against the possibility of excessive pressure on individual fish populations. But if some countries restrict the number of their fishing units to the minimum required to take their quotas over prolonged periods of time, while others make no effort to restrict entry into the fishery and exhaust their quotas in much shorter periods, all nations participating in the fishery would be under pressure to concentrate on readily accessible locations.[71] The result might be overfishing of separable sub-groups of the fish populations involved, precisely the undesirable biological effect of short fishing seasons produced by an overall catch limit alone.[72]

Furthermore, unless each nation rationalizes its effort to catch its quota, there may be great pressure upon each to violate its quota restrictions.[73]

It might be suggested that this problem be met by fixing a separate overall catch limit and national catch quota for each stock of cod and haddock. However, it seems generally agreed that it is very difficult, if not impossible, to enforce a system of regulation based upon the needs of different fish stocks in different parts of the areas in question.[74] In time, as operating experience builds up with the proposed single overall catch limit and a single overall catch quota for each nation participating in the fisheries, it may be possible to shift to individual area regulation.

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[66] *Ibid.*

[67] *Ibid.*

[68] *Ibid.*

[69] See *ibid.* The Working Group suggested that there should be a credit of 90 per cent of any shortfall, but it is difficult to see why a nation should be credited in a succeeding year for failing to catch its quota.

[70] *Id.* at 4.

[71] Economic Aspects of Fishery Management, at 8.

[72] *Ibid.*

[73] Note by the United Kingdom Commissioners on the Regulation of Fishing Effort, *supra* note 55, at 5.

In the meantime, excessive pressure on individual fish populations may be relieved in a number of ways: closed seasons of suitable length in certain areas (excepting the small, immobile fleets of some of the North Atlantic participants); advisory quotas for individual areas; and possibly even the adoption of a weighted system of quotas, with smaller allowable catches from areas under heavy pressure and larger allowables for areas in which expansion of effort could be accommodated.

To alleviate these difficulties and assure that each nation will rationalize its fishing effort, it has been proposed that ICNAF should (by negotiation) directly allocate to each participating nation the maximum amount of fishing effort that it may devote to the fisheries in question, making certain that the total amount of fishing effort thus allocated is no more than required to maximize net economic return from these fisheries.

There are both practical and policy objections to this alternative. The United Kingdom ICNAF Commissioners well stated what many writers have pointed out about the concept of maximum or optimum net economic yield when applied to fisheries involving several species, wide geographic distribution of fishing effort and international participation (27 nations in our case):

> *The theoretical maximum economic yield will be affected by changes in market prices and other relevant factors which reduction in effort may be expected to bring about and the variation between countries of fishing methods, economic and social conditions [producing different cost structures and different market preferences], as well as international trade in fish, would make it difficult to determine on any objective basis at what level of total fishing effort the maximum economic yield would be obtained. There may in fact be no single optimum economic level of effort for an international fishery.*[75]

It is very doubtful, therefore, whether international agreement could be reached on the application of the principle of maximum net economic yield to any specific situation. However, unless the direct limitation of fishing effort is based upon some such principle, it will not benefit the participating nations, unless there is overfishing in the biological sense and it succeeds in restoring the maximum sustainable yield. The proposed overall catch limit and accompanying national catch quotas will also maintain the maximum sustainable yield, an objective all nations profess. In addition, they will enable any nation that wishes to do so to rationalize its own effort to catch its quota so as to maximize its net economic yield.

From the biological point of view, too, the proposed system may be preferable to the direct limitation and allocation of fishing effort. If stocks are more (or less) available to capture than usual, a direct effort limit, unlike a catch limit, would result in the taking of too many (or too few) fish.[76]

As a practical matter, also, it is impossible to devise a workable program to restrict fishing effort directly. Total fishing effort is a function of many factors: the number of vessels employed; their size, power and type of gear; the number of hours spent in fishing; and the particular season and grounds fished.[77] Regulation in terms of one factor only, for example limiting the number of hours spent in fishing, could be nullified by the adjustment of one or more of the other factor, such as curtailing the fishing time of the least efficient units in the fleet or improving the gear used.

There are no internationally-accepted standard units of "fishing effort" which combine all these factors. Even if there were, constant adjustments would be necessary to take account of new designs and technological innovations in both vessels and gear. Moreover, if all other problems were solved, it would be virtually impossible to enforce direct limits on the amount of fishing. It might be possible to check on the number of hours fished by relatively small vessels making short trips to fishing grounds near their home ports. The number of trips per annum made by vessels fishing farther from home could probably be restricted. Within limits, this might control the number of days spent on fishing grounds, but it would be impossible to limit the number of hours fished.[78]

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[74] See, for example, *id.* at 7.

[75] *Id.* at 9.

[76] *Id.* at 4.

[77] *Ibid.*

Finally, even if all these difficulties could be surmounted, this alternative would be undesirable. In effect, it forces all nations participating in the fisheries to adopt a particular domestic policy. The panel will recommend that the United States take steps to rationalize the fishing effort of the United States in catching its quota, if and when the proposed quota system is adopted. But how a participating nation wishes to proceed to catch its quota is primarily its concern; all nations should not be expected to proceed in the same fashion. National aspirations and policies differ, particularly between market-oriented and planned economies and different nations depend in different degrees upon fishing as a source of income, employment and foreign exchange.

Unlike the direct limitation of fishing effort imposed by an international fishery commission upon each nation, the proposed national catch quota system gives each nation the opportunity to use its quota in the manner it thinks is best suited to its internal conditions–to maximize its net income from the fisheries, to prevent serious unemployment in fishing communities with no viable alternatives, to provide fish at the lowest possible price to consumers, or to improve its balance of payments situation; or to pursue two or more of these aims in varying degree.

The panel recognizes that unless each nation seeks to rationalize its efforts to catch its quota, the whole quota system may be jeopardized. Unfortunately, then, it is not quite true that each nation can work out its own way of catching its quota entirely without prejudice to the other participants in the fisheries. The panel would prefer to await experience with the actual administration of the recommended quota system before reaching fixed conclusions about the interdependency thereunder of decision-making by the participant nations.

On the whole, the panel concludes that the recommended quota system represents the best feasible basis for the management of the North Atlantic cod and haddock fisheries.

5. Some Special Problems

a. New Entrants The most serious obstacle to the workability of the proposed quota system will be the claims of prospective entrants to the fisheries. In their present state, the North Atlantic fisheries are not overly attractive from an investment standpoint, yet the past decade has seen a rapid expansion of the activities of several relatively new participants in these fisheries. If an effective national catch quota system is developed, with the potential of sizable economic returns to those participants which rationalize their operations, these fisheries will become a tempting area of investment for new entrants. Modern high seas fishing technology has already demolished most of the distance barriers and is well on the way toward further reduction in the cost of fishing over broad areas of the ocean. The unrestricted entry of new nations would dissipate the economic benefits expected from the proposed quota system.

The problem of new entrants would be further complicated if the nationals of an existing participant sought to evade the assigned quota by flying the flag of a nation which had not previously participated in the fishery or by simply investing in the fisheries of such a nation. To make the proposed system workable, it would be necessary to debit the catch obtained by such foreign operations or investment to the quota of the existing participant. In practice, this may not prove to be a difficult problem because existing participants would have sufficient incentive under the proposed system to discourage such efforts at evasion.

Apart from this special problem, however, it will not be easy or equitable to deny access to profitable North Atlantic fisheries to new entrants, particularly if they are developing countries for whom animal protein foods have great importance.

There are many ways in which this problem could be handled. A given percentage of the overall catch limit–perhaps 10 percent–could be reserved for new entrants; they would be required to take their quotas with vessels carrying their flags. To the extent that new entrants did not take up all of this percentage, it would be allocated to existing participants. This would permit full scale exploitation until such time as the need arose to accommodate new countries. New entrants might also gain access to the fisheries by purchasing all or part of the quota of an existing participant.

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[78] *Ibid.*

Whether this approach to the problem succeeds will depend upon the number of new entrants and the economic impact of their entry upon existing participants. It is impossible to predict this number or impact.

As an alternative, it has been suggested that as economic gains are realized from the proposed quota system, compensation should be provided for those countries which undertake to abstain from the North Atlantic fisheries. The difficulty with this suggestion is that all the countries in the world other than the existing participants are potential abstainers and recipients of compensation. It would not be practical to determine the amount of compensation that should be paid them or how that amount should be divided among them, nor would the amounts received, in all probability, be sufficient to induce the potentially serious new entrants to abstain.

The panel faced a similar problem in connection with its recommended framework for exploring and exploiting the mineral resources of the deep seas and the solution suggested in that instance might prove to be feasible here. A portion (specified by ICNAF) of the net economic gain realized from the proposed quota system might be collected by ICNAF and paid into the International Fund recommended in Chapter III. The efficacy of this alternative would depend upon the extent to which it actually induced nations not participating in the fisheries to refrain from seeking entry. Consideration should be given to the possibility of a new international convention requiring abstention from fisheries governed by quota systems such as that proposed for the North Atlantic fisheries, in return for which payments to an International Fund would be made.

b. The Position of Some Coastal States The fishermen of some coastal States bordering on the Northwest Atlantic may be unable to shift their excess capacity to other fisheries and may, therefore, present a special problem. The panel has already recommended that if it becomes necessary to close subareas of the North Atlantic which are threatened by overfishing, these small inshore fishermen—of Newfoundland, Iceland and Greenland—should be excepted.

However, it may be necessary to go further to protect them. In its Resolution on "Special Situations Relating to Coastal Fisheries", the 1958 Geneva Convention recommended that preferential treatment should be given to the coastal State "whose people are over-whelmingly dependent upon coastal fisheries for their livelihood or economic development" or "whose coastal population depend primarily on coastal fisheries for the animal protein of its diet and whose fishing methods are mainly limited to local fishing from small boats."[79]

The panel accepts the principle of this Resolution and recommends that the needs of these coastal States should be given special consideration when national catch quotas are allocated.

Whether a coastal State bordering on the North Atlantic or a region thereof is "overwhelmingly dependent upon coastal fisheries" might be determined by the percentage of its gross income accounted for by actual coastal fishing operations, fish processing and supplying the various sections of the fishing industry. Such a coastal State or region would be eligible for special consideration if all these sections of the fishing industry accounted for a given percentage (15 to 20 percent) of its gross income. The exact percentage, of course, would be a matter for negotiation.

The "special consideration" to which the coastal State or region would then be entitled would be the allocation of a catch quota not less than that which would leave its percentage of the catch equal to its average percentage during a reasonable number of years prior to the allocation. However, this percentage need not be determined by a rigid principle; it, too, may be negotiated.

The concern of the United States for coastal States which are developing countries should also be demonstrated by increasing United States efforts, bilaterally as well as multilaterally, to aid them in improving their fisheries capabilities. In fiscal 1966, the Agency for International Development committed only $100,000 for fisheries; in fiscal 1967, the amount committed increased to $2.7 million and in fiscal 1968, to $7.1 million, of which $3 million represented a loan to Korea for fishery equipment.[80] The United States also contributed in fiscal 1968 approximately $3.6 million to UN organizations for fisheries development.[81]

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[79] Resolution VI, 2 Official Records of the Geneva Convention on the Law of the Sea 144, U.N. Doc A/CONF. 13 L. 56.

C. Implications of Recommended Quota System for Other Fisheries

The problems confronting the nations participating in the North Atlantic cod and haddock fisheries are not unique. The situation in the North Pacific is rapidly approaching that of the North Atlantic and the recommended quota system could well be given early consideration for the fisheries of that area also. It would resolve the impasse over the abstention doctrine.

Furthermore, the fleets of long-range vessels are steadily increasing and more and more countries in all parts of the world, including Ghana, Greece, Israel, Italy, South Korea, Spain and Taiwan, are starting to operate such vessels. This development will aggravate the problem of disposing of the excess fishing capacities of nations that will choose to reduce their inputs of capital and labor to the minima required to take their quotas of the North Atlantic cod and haddock fisheries.

To the extent that the excess capacity consists of obsolete vessels, the likelihood is great that the alternative uses for them would not cover out-of-pocket expenses and they would be retired. Furthermore, there are still substantial stocks of fish in the North Atlantic itself which are not fully exploited: herring, blue whiting, capelin, squid, sand eels, redfish.[82] Excess capacity could be shifted to exploiting these stocks. The larger vessels could also shift to the central and south Atlantic, including the trawling grounds off the West Coast of Africa, which offer very abundant hake resources and, in the case of Northwest Africa, other more valuable species as well.

If presently redundant capital and labor can be shifted to underdeveloped fisheries in the North Atlantic and other areas on a basis that covers the opportunity costs of the variable factors employed, it is desirable to do so. Furthermore, the pressure to redeploy such excess capacity should itself speed the development of techniques and acquisition of scientific knowledge required for profitable fishing of underutilized stocks. In this way, the recommended quota system will help to achieve the primary world objective of encouraging development of the vast food reserves of the sea.

It must also be noted that as a result of the recommended quota system, fishing pressure will be shifted from the North Atlantic to other areas, including areas which are already beginning to show signs of depletion but are not covered by any fishery convention or are covered by conventions that are in their formative stages.

In the long run, therefore, international consideration will have to be given to the impact of the proposed quota system for the cod and haddock fisheries of the North Atlantic, and possibly for the high seas fisheries of the North Pacific as well, upon physical yields and economic returns in all other fisheries. Eventually, this tokens the need for a world-wide system of regional fishery conventions, each tailored to its own particular biological and environmental conditions but all entering into, at least in a rough way, a truly international framework of analysis. Experience with national catch quotas for the North Atlantic cod and haddock stocks will be most helpful in solving future problems of restricting fishing effort on a world-wide scale.

D. Domestic Implications of Recommended Quota System

To help rehabilitate the commercial fisheries of the United States, the panel recommends that the United States should seize the opportunity that the recommended quota system will offer to reduce its inputs of capital and labor to the minimum necessary to catch its quota and, to this end, to encourage the development of a technically advanced and economically efficient fishing fleet. There are a number of ways in which this might be done; all would require new legislation.

For example, fishing license fees, vessel taxes or landings taxes of such magnitude might be imposed as to compel use of only the minimum number of units using the most efficient gear and methods. The same result might be achieved more gradually by initially licensing all existing vessels, making the licenses non-transferable and issuing no new ones. As the outstanding licenses began to decline and to acquire value because access to the catch quota of the United States was being limited to the point where profitable operations were in prospect, the licenses could be made transferable. The objective in view might be reached more directly by auctioning rights to fish for portions of the catch quota to the highest bidders. The portions offered should be large enough for profitable operations by a technically advanced and economically efficient fishing fleet.

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[80] The data in the text were supplied by the Agency for International Development.

[81] The data in the text were supplied by the National Council on Marine Resources and Engineering Development and the Department of State.

[82] Report of Working Group, *supra* note 46, at 4.

The panel recommends alternatives that directly limit entry for the purpose of catching the United States quota but which at the same time safeguard against monopoly and effectuate rationalization of the United States fish-catching industry gradually. However this is done, it may require displacement of men and capital equipment not easily absorbable elsewhere in the economy. It is important that the displaced fishermen[83] should be taken care of in the ways that men have been cared for who have been displaced by technological innovation on the railroads or the waterfront or by the lowering of tariffs.

E. Strengthening International Fishery Organizations

1. Fishery Conventions

The panel recommends that the existing international fishery conventions should be strengthened in the following particulars and that these particulars should be embodied in any new conventions that may be adopted:

a. Coverage The geographical area subject to the Convention should be large enough to permit fishery management on the basis of ecological units rather then species and, when necessary, should include the territorial seas. The increasing sophistication, range, and flexibility of modern high seas fishing equipment tends to make species regulation unrealistic. Even if effective, species regulation tends to shift fishing pressure to other species or to restrict development of underutilized fish in the same area. Fishery commissions should be authorized to manage ecological units whenever they conclude that the additional gains from such management are likely to outweigh the increased costs of undertaking it.

b. Membership Renewed diplomatic efforts should be made to persuade all nations interested in the fisheries in a particular area to become parties to the applicable convention. It is imperative, also, that all important fishing nations of the world adhere to the Convention on Fishing and Conservation of the Living Resources of the High Seas. Fishery conventions should also permit States that are important processors or consumers of fish to become parties.

c. Staff The fishery commissions created by the conventions should be adequately financed so that they can employ full-time, competent staffs to provide the scientific, technical and economic advice they need to accomplish the objectives of the conventions. The availability of such a staff will enhance the quality of the data upon which each commission must base its recommendations and the acceptability of the recommendations by the States Parties to the Convention.

The panel recognizes that this recommendation may not be acceptable in some areas of the world. But it is vital that it be accepted in those areas where some State members of a fishery commission lack the necessary scientific personnel or the resources to employ them.

Adequate support of these fishery commissions, including FAO fishery bodies, will not only improve the outlook for United States fisheries but will constitute a most effective form of aid to the developing nations.

d. Enforcement (1.) Enforcement of the provisions of the convention and the implementing regulations of the fishery commissions should be strengthened in one or more of the following ways:

(*a*) Each fishery commission should be entrusted with the task of investigation, seizure and arrest, but should be required to turn over the allegedly offending vessel and persons to the State of their nationality for prosecution and punishment. In time, the States Parties may come to agree upon an international enforcement code and the establishment of an appropriate tribunal to try alleged violations of the code and punish violators. But we think this time is yet far off.

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[83] There were about 128,000 U.S. fishermen on vessels and boats and on shore in 1965, a decline from more than 161,000 in 1950. In 1960, median earings for fishermen and oystermen were $2,395, while that per worker for the experienced male labor force was $4,621. Nonetheless, full-time fishermen may work at least 3 hours to every 2 worked by full-time employees in other industries.

(*b*) Any State Party should be authorized to investigate alleged violations, to seize any vessel and arrest any person there is reason to believe committed a violation, to try the alleged violation and to punish the violators.

(*c*) If the above recommendations are thought to be too derogatory of national sovereignty, or too costly to be put into effect, at least any State Party should be authorized to investigate alleged violations, to seize any vessel and arrest any person there is reason to believe committed a violation, even though only the State Party to which the offending vessel and persons belong is authorized to try the alleged violation and punish the violators.

(2.) To assure a uniform enforcement policy, (a) each fishery commission should be authorized to specify the range (minimum and maximum) of the fines for different types of violations which should be imposed by the State Party empowered to punish violations; and (b) the State Party imposing the fines should be required to turn the proceeds over to the fishery commission to be used for agreed-upon purposes.

(3.) The United States Coast Guard should be provided with adequate means to discharge the obligations of the United States with respect to enforcing the provisions of the fishery conventions to which it belongs, as well as the implementing commission regulations.

e. Dispute Settlement Dispute-settlement procedures should be agreed upon which will make the decisions of an impartial tribunal obligatory upon the States Parties to the dispute. The Convention on Fishing and Conservation of the Living Resources of the High Seas provides an excellent precedent in this respect but, unfortunately, one which has not yet been widely accepted.

The United States is not, in principle, opposed to the compulsory arbitration of fishing disputes. In February 1967, the United States proposed to Chile, Ecuador and Peru that their dispute about the extent of the fishing rights of these South American countries should be submitted to arbitration or to the International Court of Justice.[84] The CEP countries rejected the proposal. We take this opportunity, therefore, again to call attention to the anomaly that the United States has not yet ratified the Optional Protocol Concerning the Compulsory Settlement of Disputes arising out of the interpretation or application of any article of any of the Conventions on the Law of the Sea. We repeat our recommendation that the United States should ratify the Optional Protocol.

2. Additional Functions for FAO Committee on Fisheries

An international organization should be entrusted with the tasks of (a) evaluating the operations of all existing regional fishery conventions and recommending measures to improve the work of each, as well as to coordinate the activities of all; and (b) recommending the establishment of new, international fishery conventions.

At present, the most appropriate United Nations organization to entrust with these tasks would appear to be the FAO Committee on Fisheries, even though, as indicated in Appendix B, the Soviet Union is not a member of FAO.

The establishment of new conventions should not await the overfishing or threatened depletion of particular fish stocks. The commissions created by these conventions should be given authority to recommend measures to maximize the utilization of fishing resources, consistent with their adequate conservation, and to aid the developing countries in promoting their fisheries and in training scientific and technical personnel for this purpose. As development proceeds, these commissions should anticipate problems and recommend the necessary regulatory measures to assure the conserving and economically efficient utilization of the living resources of the seas.

It is not essential that all the new commissions be created under the aegis of FAO. The Organization of American States may prove to be the most suitable agency to set up and supervise regional fishery conventions in Latin America. Similar regional organizations may be more appropriate in other areas. But it is important to charge some international organization with responsibility for taking a world view so that, in time, a world-wide system of regional fishery conventions can be established. It may then also become possible to establish as international law the duty of a new entrant to comply with existing, non-discriminatory, conservation and economic regulatory measures.

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[84] Hearings, *supra* note 39, at 59.

F. Preferential Treatment of the Coastal State

The Convention on Fishing and Conservation of the Living Resources of the High Seas recognizes the "special interest" of the coastal State "in the maintenance of the productivity of the living resources in any area of the high seas adjacent to its territorial sea." It does not deal with the question of access to these resources but only with that of their conservation.

However, the practice of States, including the United States, since the Geneva Conventions on the Law of Sea, has sanctioned as part of customary international law an exclusive fisheries zone to a distance of 12 miles from the baselines for measuring the breadth of the territorial sea.

The panel has recommended that some coastal States bordering on the Northwest Atlantic should be given preferential treatment in the administration of the proposed system of national catch quotas for the cod and haddock fisheries of that region. The question remains whether some preference should be extended to the South American countries which are claiming fisheries zones of widths unwarranted by any existing treaties or by customary international law, as a way to eliminate this source of international tension.

The situation off the coast of South America differs from that in the Northwest Atlantic because Chile, Ecuador and Peru take only relatively small quantities of the tuna sought by the United States fishing fleets. This situation is typical of that confronting developing coastal States which fear that their future access to the living resources adjacent to their territorial seas may be foreclosed by the operations of distant-water fleets.

To the extent, however, that the existing framework safeguards the freedom of distant-water fleets to fish for stocks which coastal fishermen are not exploiting fully, it promotes the objective, shared by all nations, to maximize the use of the living resources of the sea. And it obviously promotes this objective without hurting the coastal States in question. The panel assumes that the distant-water fleets are not overfishing or interfering with coastal fishing for other stocks either by gear conflict or upsetting the ecological balance.

Indeed, Professor Dodyk has suggested that the right of foreign fishermen to fish within the 12-mile limit, and even within territorial waters, should be recognized under such circumstances.[85] But while it would be difficult to dispute the claim of the coastal State to impose fees or taxes which are not prohibitive or discriminatory upon foreign fishermen within its territorial sea or 12-mile limit, or to exclude foreign fishermen therefrom when it is able and willing to exploit the resources in these waters fully, similar claims by the coastal State in the high seas beyond the 12-mile limit are unwarranted.

Nevertheless, under the conditions specified in the Geneva Convention Resolution on "Special Situations Relating to Coastal Fisheries,"[86] some preference should be accorded the coastal State even with respect to access to the fisheries of the high seas beyond the 12-mile limit. The coastal State should be assured that it will be given a reasonable opportunity to participate in the future exploitation of stocks not now fished by it.[87] This assurance should be buttressed by an agreement to allocate national catch quotas whenever the coastal State is ready and willing to enter the fishery and requests such quotas.

The quotas should be allocated so as to guarantee the coastal State a minimum amount or percentage of the catch which it should be required to take with vessels carrying its flag. It should not be permitted to sell any part of its uncaught quota and indeed should be penalized if its actual catch falls either below or above its quota. Once it establishes fishing operations in line with its quota, it may be permitted to sell its quota. The quota itself should not be regarded as equivalent to a right of exclusive access, which the coastal State does not otherwise possess, because then every coastal State would claim a quota just to be able to sell it. Until the coastal State itself establishes a fisheries operation, it has no investment to give it an equitable basis for the right to sell its quota.

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[85] Dodyk, *supra* note 26, at 129-36.

[86] See text accompanying note 79 *supra.*

[87] See McKernan, International Fishery Policy and the United States Fishing Industry 2, Paper Presented to Conference on the Future of the United States Fishing Industry, Seattle, Washington, March 24-27 (1968).

It is impossible to predict whether these assurances to the South American States will suffice to induce them not to seize United States fishing vessels outside the 12 mile limit. But it is also difficult to see what else the United States can reasonably be expected to offer.

G. The Territorial Sea

If the suggested means of preferring the coastal State proves to be acceptable, it may remove the impetus to the extension of the territorial sea that derives from concern over access to fishery resources. It may then become possible to secure agreement on a narrow territorial sea consistent with the totality of American interests in the oceans and assurance of right to pass through and fly over international straits.

H. Amendment of the Fisherman's Protective Act

Until the existing disagreements with the coastal States of Latin America are resolved–either by adoption of the panel's proposals or in some other way–the panel recommends that the policy of indemnification embodied in the Fisherman's Protective Act of 1967 should be continued. Only by permitting its fishing fleet to continue to operate within the 200 mile zone to which these countries claim exclusive access can the United States effectively oppose these extravagant claims. But then the United States must stand behind its nationals who are the instruments of its policy.

The Act's requirement that the amount of aid a country is scheduled to receive from the United States must be cut by the total of unpaid United States claims against it for seizing United States fishing vessels is preferable to the requirement in the Senate-passed version of the bill that *all* assistance to a seizing country be suspended until it satisfies such claims. Nevertheless, the panel concludes that this provision of the 1967 Act should be repealed because it restricts the flexibility the President must have in exercising his foreign policy responsibilities. It subordinates all foreign policy objectives of the United States to the one objective of resisting unwarranted claims to exclusive access to certain fishery resources. The total amounts paid under the Act will not be great and may even be less than the losses United States interests will sustain if other retaliatory measures or diplomatic ruptures result from overzealous collection efforts.

Chapter 5 An International Legal-Political Framework for Conducting Scientific Inquiry in the Oceans

I. OBJECTIVES OF FRAMEWORK

To observe, describe and understand the physical, geological, chemical and biological phenomena of the marine environment, the marine scientist must conduct investigations on a global basis. Scientists of all nations share the interest in conducting such investigations, the benefits of which will accrue to all nations. The panel, therefore, recommends an international legal-political framework which will give the world's scientists the maximum freedom of inquiry. At the same time, it supports United States efforts to encourage international scientific cooperation.

II. EXISTING FRAMEWORK: GENERAL

The existing international legal-political framework does not facilitate the freedom of scientific inquiry on a global basis. The prior consent of the coastal State is required (a) to conduct scientific investigations in its internal or territorial waters, except insofar as the right of innocent passage through these waters may include the right to engage in scientific inquiry in the course of such passage, a question considered below; (b) to emplace installations for research purposes on the beds of its internal or territorial waters; (c) to conduct fishery research in a coastal State's exclusive fisheries zone; or (d) "in respect of any research concerning the continental shelf and undertaken there."[1]

It should also be recalled that nations claim territorial seas of breadths varying from 3 nautical miles to 200 miles or more; they delimit their internal and territorial waters in ways that serve to extend them; and the seaward limit of the Continental Shelf is uncertain. These factors tend to enlarge the areas of the oceans in which consent of the coastal State is a condition precedent to the conduct of scientific inquiry.

Experience to date cannot be said to demonstrate that the existing legal-political framework is a serious obstacle to world-wide scientific inquiry, but it has the potential of becoming such an obstacle. In recent years, a few coastal States have begun to impose stringent and complicated procedures that must be followed to obtain their consent for the conduct of research requiring it. The recent Brazilian decree is an example and the trend it exemplifies is growing.[2]

The United States should join with other nations to support and implement the principle of maximum freedom for scientific inquiry. Some of the panel's recommendations to this end can be carried out within the confines of the existing framework, but others call for a new framework.

III. RECOMMENDATIONS FOR ACTION WITHIN EXISTING FRAMEWORK

A. Research in Internal and Territorial Waters

1. Scientific Inquiry Incidental to Innocent Passage

The Convention on the Territorial Sea and the Contiguous Zone recognizes the "right of innocent passage" by ships of all nations through the territorial sea[3] of a coastal State and through its waters which, though previously considered part of its territorial sea or of the high seas, are now internal waters because of the use of a system of straight baselines to measure the breadth of its territorial sea.[4] Article 14 of the Convention defines the "right of innocent passage" as follows:

> *2. Passage means navigation through the territorial sea for the purpose either of traversing that sea without entering internal waters, or of proceeding to internal waters, or of making for the high seas from internal waters.*

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[1] Convention on the Continental Shelf, Art. 5 (8).

[2] Decree No. 62.837 of President of Republic of Brazil, June 6, 1968. From 1963 through 1966, the Department of State informs us, there were only six instances in which foreign nations refused requests of American-flag vessels to conduct scientific research on their continental shelves or in their territorial seas. Since January 1967, there have been 12 such instances.

[3] Convention on the Territorial Sea and the Contiguous Zone, Part I, Sec. 1., Art. 14 (1).

[4] *Id.*, Part I, Sec. 1, Art. 5 (2).

3. Passage includes stopping and anchoring, but only insofar as the same are incidental to ordinary navigation or are rendered necessary by force majeure *or by distress.*

4. Passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State. Such passage shall take place in conformity with these articles and with other rules of international law.

5. Passage of foreign fishing vessels shall not be considered innocent if they do not observe such laws and regulations as the coastal State may make and publish in order to prevent these vessels from fishing in the territorial sea.

6. Submarines are required to navigate on the surface and to show their flag.

Article 17 also requires foreign ships exercising the right of innocent passage to:

comply with the laws and regulations enacted by the coastal State in conformity with these articles and other rules of international law and, in particular, with such laws and regulations relating to transport and navigation.

a. General These articles of the Convention do not make clear the extent to which a vessel may engage in scientific inquiry while exercising the right of innocent passage. Apart from this right, of course, the prior consent of the coastal State is required to authorize any vessel or submersible (manned or unmanned; bottom crawler) to enter its internal or territorial waters for the purpose of conducting research therein.[5]

The intent of these Articles, the panel concludes, would be served best if they are interpreted to permit scientific inquiry when it is incidental to passage of a vessel through the waters in question but not when it is the purpose for which the vessel entered these waters.[6] For example, this interpretation would permit "ships of opportunity," i.e., commercial or naval vessels on which laboratories are installed for scientific research purposes, to make scientific observations while exercising the right of innocent passage. It would also permit an oceanographic vessel to make such observations, but only when it traverses the territorial sea en route to or from its destination. These observations by a ship of opportunity or oceanographic vessel would have to be made while the vessel was underway, since stopping and anchoring for this purpose are prohibited by the Convention.

b. Research Submersibles To exercise its right of innocent passage, every submarine is required to navigate on the surface and to show its flag. This requirement may make exercise of the right of innocent passage very difficult, if not impossible, for research submersibles which have not been specially designed to navigate on the surface.

c. Research Buoys While there is strong support for the view that the prior consent of the coastal State is required before oceanographic buoys may be placed in its internal or territorial waters,[7] it has been suggested that a right of "innocent access" might be claimed for such buoys.[8]

d. Limits on "Innocent Research" Even if the Convention on the Territorial Sea and the Contiguous Zone is interpreted to recognize the claims to engage in scientific research while exercising the right of innocent passage and to "innocent access" for research buoys, it is doubtful whether these claims would prevail if a coastal State enacted laws or regulations expressly prohibiting foreign scientific research in its internal or territorial waters. Such laws and regulations may be enacted because the coastal State regards such research as prejudicial to its security or for other reasons.[9] Vessels violating the regulations may be subject to sanction or excluded from passage, if the violation is in fact prejudicial to the peace, good order or security of the coastal State.[10]

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[5] Burke, International Legal Problems of Scientific Research in the Oceans 18. (Prepared for National Council on Marine Resources and Engineering Development, August 1967).

[6] *Id.* at 21.

[7] UNESCO, Intergovernmental Oceanographic Commission, Preliminary Report of UNESCO and IMCO on the Legal Status of Unmanned and Manned Fixed Oceanographic Stations 6, NS/IOC/INF/34 (1962).

[8] Burke, Law and the New Technologies, in The Law of the Sea 204, 215-16 (Alexander ed., 1967).

[9] *Id.* at 22. Burke cites a Bulgarian decree of October 10, 1951 which proclaims:

Foreign ships may not engage, while in the territorial or internal waters or ports of the People's Republic, in sounding, research, study, photography . . . or make use of radio transmitters, radar, echo sounding or like devices other than those intended for purposes of navigation.

Furthermore, a coastal State's laws and regulations, such as those enacted by the United States, prohibiting foreign fishing in its territorial waters are regarded as forbidding also the taking of fish for research purposes, as well as all other research activities relating to fisheries, whether conducted in the course of innocent passage or not.[11]

2. Recommendation

In the absence of a prohibitory law or regulation enacted by a foreign coastal State, it would be reasonable for the United States to assert, unilaterally, the right of an American-flag vessel to engage in scientific inquiry while exercising the right of innocent passage through the internal or territorial waters of the foreign coastal State and to grant such a right to foreign-flag vessels exercising the right of innocent passage through United States waters. However, the panel does not think it would be wise for the United States to adopt unilaterally such an interpretation of the Convention. To do so might give a foreign coastal State reason to suspect that every American-flag vessel passing through its waters was also undertaking some kind of scientific inquiry unknown to it. As a result, there might be interference with the right of innocent passage, which is vital to the United States. Nor would any long-run benefit to marine science ensue, because the coastal State could always enact legislation expressly prohibiting scientific research in the course of innocent passage through its waters.

The panel does not think much is to be gained by unilateral claims to innocent access for research buoys. Such buoys would be peculiarly vulnerable to acts of the coastal State. Accordingly, the panel recommends that the question of scientific research in the internal and territorial waters of coastal States should be the subject of a new, international convention, as recommended below. Pending the negotiation of the new convention, it may be worthwhile for the United States to seek bilateral or regional agreements interpreting the Convention on the Territorial Sea and the Contiguous Zone, together with general principles of international law, as authorizing the conduct of scientific inquiry in the course of innocent passage, as well as the "innocent access" of research buoys.

Moreover, to encourage international scientific cooperation, the United States should announce that (a) it will consent, upon proper notice, to the conduct, in its territorial waters, of scientific research which is part of an international, cooperative project sponsored or endorsed by the Intergovernmental Oceanographic Commission (IOC)[12] and (b) in return for such consent, it will require that (*i*) it be given the right, if it so desires, to participate or to be represented in the research; (*ii*) the results of the research shall be published; and (*iii*) upon its request, the basic data acquired shall be made available to it.

B. Research in the Contiguous Zone

1. Fishery Research in the Exclusive Fisheries Zone

To date, no State has sought to delimit a zone contiguous to the territorial sea for the sole purpose of extending the coastal State's control over scientific research activities in the zone. However, coastal States, including the United States, claim exclusive rights of access to the living resources of the sea up to 12 miles or more from the baselines from which the breadth of the territorial sea is measured. The multiplicity of these claims seems to have resulted in a new kind of contiguous zone recognized not by the Convention on the Territorial Sea and the Contiguous Zone but by customary international law.[13] In the exclusive fisheries zones thus created, coastal States, including the United States, claim the right to prohibit fishery research (including the taking of fish specimens) without their prior consent.[14]

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[10] *Id.* at 22-23.

[11] *Id.* at 24.

[12] For a brief description of IOC, See Appendix B to this report.

[13] See Burke, *supra* note 8, at 32.

[14] The authority stems from the 1964 and 1966 Acts, read together. See notes 13 and 17 to Chapter 3.

2. Definition of Fishery Research

The authority of the coastal State over fishery research activities in its exclusive fisheries zone is not as great as it is over research activities in its internal and territorial waters, because the authority exercised in the zone must relate to the purpose for which the zone was created: the protection of claimed exclusive fishing rights. Therefore, it becomes both important and difficult to define the "fishery research" that may be prohibited.

The Scientific Committee on Ocean Research (SCOR) of the International Council of Scientific Unions (ICSU) defined fishery oceanography generally as the study of the living resources of the sea using those aspects of oceanography (including biology, physics, chemistry, geology, and meteorology) that affect their abundance, availability, and exploitation. Under this definition, virtually all scientific investigations in the exclusive fisheries zone could be taken to involve fisheries. However, for purposes of the 1966 statute under which the United States proclaimed an exclusive fisheries zone of 12 miles (including the three mile territorial sea), an official of the State Department has informally defined "fishery research" in a more restrictive fashion:

> *Fishery research is the study of the biology, environment, abundance, availability, and exploitation of fish or other aquatic organisms for the purpose of facilitating the utilization of those organisms for sport or commercial purposes.*[15]

This definition makes the purpose of the research determinative. Research for purposes other than "facilitating the utilization of those organisms for sport or commercial purposes" may be conducted in the exclusive fisheries zone without the prior consent of the coastal State, even if the research involves marine organisms and proves to be valuable for fisheries. Although this definition is intended to extend the area of freedom for scientific inquiry, Dr. M. B. Schaefer has expressed doubts about its usefulness:

> *I submit that this defintion is not operationally very useful, because of the difficulty of determining the motives of the scientific complement of any particular research vessel. I doubt, therefore, whether I can rely upon it to determine whether or not I should request permission from any given foreign country before conducting any research in biological oceanography, or related subjects, in its exclusive fisheries zone.*[16]

The panel shares this doubt. Because of the uncertainty, scientists will be well advised to avoid the possibility of unpleasant, international incidents by seeking permission of the coastal State to conduct almost any study of living resources in the exclusive fisheries zone.

The panel also shares the general concern expressed by Dr. Schaefer about the restriction of research in the exclusive fisheries zone.

> *Perhaps the greatest disadvantage to science of the continuing extension of the sovereignty of the coastal State over larger pieces of the high seas is that it will become increasingly difficult, and in some cases impossible, to conduct research requiring critical data from areas under the jurisdiction of some coastal States. This problem could become particularly serious, for example, in the case of some of the highly migratory marine animals that inhabit different sea areas at different stages of their life cycles.*
>
> *Indeed, a doctrine of exclusion with respect of fisheries research, since it obviously includes studies of the life history and ecology of the exploitable organisms, can seriously militate against the conservation of the living resources of the high seas, in instances where the organism which occurs on the high seas also occurs in an exclusive fishing zone, and the researchers are unable to do their work in such zone.*[17]

3. Recommendation

The panel does not think that the difficulties pointed out by Dr. Schaefer can be entirely surmounted by new attempts to define "fisheries research" restrictively. We have no alternative to propose to the State Department's informal definition. There is need in this area for a new international convention of the kind recommended below; pending the negotiation of such an agreement, however, the panel recommends that the United States should define "fishery research" so that foreign scientists will not require its consent to conduct research (including the limited taking of fish specimens) in its exclusive fisheries zone for the purpose of facilitating the utilization of fish exploited wholly or in large part outside the zone.

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[15] Memorandum from William L. Sullivan to Stanley Futterman, Assistant Legal Advisor, Department of State, Aug. 2, 1967.

[16] Schaefer, The Changing Law of the Sea-Effects on Freedom of Scientific Investigation, Paper Presented at the Law of the Sea Institute. University of Rhode Island, June 1967, at 15. Dr. Schaefer is Science Advisor to the Secretary of the Interior.

[17] *Id.* at 17.

No interest of the United States will be affected adversely by such a unilateral concession. Such a step may encourage other coastal States to reciprocate and all fishing States will benefit.

Furthermore, to encourage international scientific cooperation in fishery research, the United States should announce that (a) it will consent, upon proper notice, to the conduct, in its exclusive fisheries zone, of such research (including the limited taking of fish specimens) which is part of an international cooperative project sponsored or endorsed by IOC; and (b) in return for such consent, it will require that (1) it be given the right, if it so desires, to participate or to be represented in the research; (2) the results of the research shall be published; and (3) upon its request, the basic data acquired shall be made available to it.

C. Research Concerning the Continental Shelf

1. Restrictions on Research Imposed by Convention on the Continental Shelf

This Convention "introduced restrictions on the conduct of scientific research previously unknown in international law."[18] The freedoms of the high seas recognized by international law include the freedom to conduct scientific research, including inquiries concerning the bed of the high seas and its subsoil. While the Convention provides that the coastal State's exploration of the continental shelf and the exploitation of its natural resources "must not . . . result in any interference with fundamental oceanographic or other scientific research carried out with the intention of open publication,"[19] it also provides that the prior consent of the coastal State must be obtained for "any research concerning the continental shelf and undertaken there."[20] However, the coastal State is enjoined not to "normally withhold its consent if the request is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf, subject to the proviso that the coastal State shall have the right, if it so desires, to participate or to be represented in the research, and that in any event the results shall be published."[21]

2. Difficulties Raised by Provisions of Convention

There are many ambiguous provisions in the Convention which may be interpreted by coastal States to enlarge the restrictions on scientific inquiry. What is research "concerning" the continental shelf? When is such research "undertaken there"? When are conditions not "normal" so that the coastal State may withhold its consent? What is a "qualified institution"? What is "purely" scientific research? Does the Convention—or customary international law—require the prior consent of the coastal State for the use in the waters above the continental shelf of equipment, such as "photographic" sonar, which serves both scientific (geological research) and commercial (oil exploration) purposes? What is the line between "exploring" the continental shelf, for the purpose of which the coastal State exercises "sovereign rights" under Article 2 of the Convention and "fundamental oceanographic or other scientific research" with which neither the exploration of the continental shelf nor the exploitation of its natural resources may interfere?[22]

Dr. Schaefer also emphasizes that the length and uncertainty of time required to obtain permission from the coastal State may also deter scientific inquiry on and concerning the continental shelf. These factors militate against "rapid exploitation of scientific opportunities as they arise in the mind of the investigator."[23]

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[18] Burke, *supra* note 5, at 37.

[19] Convention on the Continental Shelf, Art. 5 (1).

[20] *Id.*, Art. 5 (8).

[21] *Ibid.*

[22] See Burke, *supra* note 8, at 216-17; and generally, McDougal and Burke, The Public Order of the Oceans 701-02, 713-16, 721-24 (1962).

> *The scheduling of large, expensive research vessels, so as to obtain the optimum scientific return for the funds expended is already a difficult enough problem, without throwing in this new element of uncertainty.*[24]

Finally, there is always the possibility that a coastal State may deny foreign scientists permission to conduct research concerning its continental shelf and thereby prevent them from acquiring data that may be critical for their purposes.

3. Position of United States with Respect to Some of These Questions

The United States has apparently taken the position that its consent is required only for scientific research involving physical contact with the continental shelf. Thus a pamphlet published by the Interagency Committee on Oceanography states:

> *Research on the continental shelf includes the removal of shelf samples (such as by coring and dredging) and of living resources which are unable to move at the harvestable stage except in constant physical contact with the shelf. Research on waters above the shelf or on swimming creatures is not affected.*[25]

On this interpretation, measurements of magnetic fields or gravity and the taking of acoustic subbottom reflection measurements and water samples would not be research requiring the prior consent of the coastal State.[26] However, doubt has been expressed as to whether this interpretation reflects United States practice in this matter and whether it will be accepted by other nations.[27] For example, it may be argued that the coastal State's consent is required "if the investigative technique is aimed at the surface or the subsoil of the shelf even though the physical instrumentality employed is on the surface or in the water column"; the "end result of using the instrumentality is to probe . . . into the shelf and such research is [it may be argued]undertaken there."[28]

4. Recommendations: A Policy of "Easy Access" for Scientific Inquiry

Pending the negotiation of a new international convention of the kind proposed below, the panel recommends that the United States announce a policy of "easy access" to its continental shelf for purposes of scientific inquiry. Accordingly, the United States should interpret and apply the Convention on the Continental Shelf as follows:

(a) It should declare that it will consent to the conduct of any proposed foreign scientific investigation certified by the Intergovernmental Oceanographic Commission (IOC) as meeting the requirements of the Convention of the Continental Shelf. Thus in performing this task, IOC will be guided by the criteria set forth in Article 5 (8) of the Convention, namely whether the request for approval and consequent consent by the United States "is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf." Cooperative projects sponsored or endorsed by IOC will obviously fall within these criteria. Because IOC is an intergovernmental organization and one in which coastal States predominate, coastal States should have confidence in its actions.

(b) It should give the terms "qualified institution" and "purely scientific research" the broadest possible interpretation and so, for example, consent to scientifically-valuable exploration for mineral resources. (The United States, of course, will retain its "sovereign right" to exploit the natural resources of its continental shelves and exclude all others from exploiting them).

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[23] Schaefer, *supra* note 16, at 16.

[24] *Ibid.*

[25] Interagency Committee on Oceanography, U.S. Oceanic Research in Foreign Waters, ICO Pamphlet No. 25, January 1966, at 7.

[26] Schaefer, *supra* note 16, at 14.

[27] Burke, *supra* note 5, at 52, 58; Schaefer, *supra* note 16, at 14. For a summary of the argument that the United States position may be a too restrictive interpretation of the Convention, see Burke, *supra* note 5, at 58-60. (Professor Burke himself supports the less restrictive view. *Id.* at 58.)

[28] Burke, *supra* note 5, at 60.

(c) It should state that it is prepared to grant applications by foreign scientists for permission to conduct broad categories of research without requiring them to make repeated requests for consent to engage in individual projects falling within an approved category.

(d) It should interpret the Convention as requiring the prior consent of the coastal State only for research concerning the continental shelf which involves physical contact with it. Even if such physical contact occurs, as when an installation for scientific research is placed on the continental shelf, it should stress that the prior consent of the coastal State is not required if the research concerns the superjacent waters and not the continental shelf.

This policy of "easy access," of course, will remain subject to the provision of the Convention that the United States shall have the right, if it so decides, to participate or to be represented in the research and that in any event the results of the investigation shall be published.

The panel recommends that these specific steps toward an "easy access" policy shall be taken by the United States unilaterally. The United States will benefit from the increased knowledge resulting from such a policy and other coastal States may thereby be encouraged to reciprocate.

D. Research in the High Seas, i.e., Beyond the Territorial Sea

While the freedom to conduct scientific investigations in the high seas is recognized by general principles of international law, this freedom is limited in the exclusive fisheries zones and by the requirements of the Convention on the Continental Shelf.

A joint UNESCO-IMCO Report drew the following implications from these principles:

2. No state may exercise exclusive sovereign rights of the high seas for the conduct of research by means of fixed oceanographic stations.

3. No state may restrict the reasonable conduct of such research by other governments or by individuals over whom it has no personal jurisdiction.

4. States are under a duty to ensure that such research undertaken by them or their nationals is conducted with reasonable regard to the interests of other States in their exercise of the freedom of the high seas.

5. A State is permitted by international law to place additional restrictions on the conduct of research on the high seas for its own nationals and vessels, but not for persons over whom the State has no jurisdiction.[29]

Although the Report is principally concerned with the use of buoy or data stations, its conclusions also apply to the use of any other method or device for the conduct of scientific investigations.[30] These conclusions also underscore the need for international cooperation in the conduct of research in the high seas. Without such cooperation in the establishment and maintenance of a world-wide system of ocean data stations, it will be difficult, if not impossible, to detect those who might interfere with a station or the data thereon.[31]

IV. A NEW INTERNATIONAL CONVENTION, AND INTERIM BILATERAL AND REGIONAL AGREEMENTS, ON MARINE SCIENTIFIC INQUIRY

The panel recommends that the United States take the initiative to propose a new international convention on marine scientific inquiry which should embody the essential provisions set forth below. Pending the negotiation of such a convention, the United States should seek to enter into bilateral and regional agreements embodying the same provisions.

a. Scientific research in the territorial waters or on and concerning the continental shelf of a coastal State may be conducted without its prior consent, *provided that* (1) the coastal State is given prior notification of (*a*) the intent to carry on such research, (*b*) the period or periods of time during which the research will be conducted and (*c*) a description of its objects and methods, sufficiently in advance of its commencement so that the coastal State, if it so decides, may participate or be represented in all or part of the research; and (2) the investigators agree to publish the results of the research.

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[29] Preliminary Report of UNESCO and IMCO on the Legal Status of Unmanned & Manned Fixed Oceanographic Stations, UN Doc. NS/IOC/INF/34, at 11 (1962).

[30] Burke, *supra* note 5, at 78.

[31] *Id.* at 81.

For this purpose, as well as for the purpose of all the recommendations made herein, the "territorial waters" of a coastal State shall include waters which were once part of the territorial sea or the high seas, but are now internal waters because of (*a*) the use of a system of straight baselines to measure the breadth of the territorial sea; or (*b*) the closing of bays in accordance with Article 7 of the Convention on the Territorial Sea and the Contiguous Zone.

b. Fishery research (including the limited taking of fish) may be conducted in the exclusive fisheries zone of any coastal State, subject to the provisos set forth above.

c. Research submersibles may be used in the conduct of scientific research otherwise authorized, even if they do not navigate on the surface, *provided that* the coastal State is also notified of the time, place and manner of their use sufficiently in advance to assure safety of navigation.

d. Research buoys may be placed in any coastal State's territorial waters and provision shall be made for their protection, as well as for the protection of research buoys placed in the superjacent waters of the continental shelves or in the high seas beyond the continental shelves, against unwarranted interference from any source. The coastal State, however, may specify reasonable requirements for buoy location, lighting, marking and communications in its territorial waters.

It will not be difficult to prevent abuse of the recommended provisions for free scientific inquiry. The coastal State may observe, from its vessels or aircraft, all activities carried on in the name of scientific inquiry. It also has the practical power to inspect buoys and other unmanned devices used for research purposes.

Whether a vessel or installation is engaged in mineral resources exploitation or in scientific research can readily be ascertained by observing the gear or equipment it carries and the overboard operations in which it is engaged. It may not be so easy to determine by such an examination whether a vessel is engaged in commercial fishing or scientific research, although the quantity of fish taken in the latter activity should be significantly less than in the former. However, the coastal State has an additional safeguard. It may always decide to participate or to be represented in the research itself.

Taken together, these safeguards also furnish assurance that scientific inquiry will not become a cover for espionage.

It should be noted that the panel has not recommended that the proposed new convention should apply generally to the internal waters of States. Security concerns in internal waters are too sensitive to be allayed by the safeguards we have provided in the case of other waters.

V. INTERNATIONAL COOPERATION IN MARINE SCIENTIFIC INQUIRY

Because our knowledge of the oceans and their resources is exceedingly limited and a vast, complex and diverse program of scientific inquiry transcending national boundaries is necessary to increase our understanding of the marine environment, international scientific collaboration is essential if such understanding is to come in time to benefit the living generations of mankind.

For example, no single nation has a sufficient number of scientists or ships to make the studies of the changes in the temperature of the oceans which are required to improve the accuracy of long-range weather predictions. International cooperation in making these studies will greatly reduce the cost of the undertaking for each participating nation.

Similar benefits will flow from international collaboration in ascertaining the sizes, distribution, and interrelationships of ocean fish populations, some species of which wander over great distances. Furthermore, when many countries exploit a fish stock, cooperation is necessary to give scientists access to the data and experience of each country, without which the condition of the stock cannot be assessed.

International collaboration will also make it possible for interested countries to share the costs of systematically surveying the bed underlying the high seas and its subsoil—an enormous task which will require the continuous operation for many years of many highly equipped vessels and an international navigation network.

Oceanographic research, too, often calls for a diversity of scientific competence and facilities which is beyond the capacity of any one nation.

Finally, if all nations are to benefit from the research done by each in particular fields of oceanography, such as the study of primary organic production in the oceans, they must agree on the use of comparable methods of research.

For all these reasons, the panel approves the many initiatives which the United States has taken to encourage international scientific collaboration and establish an international data exchange and processing system.[32]

We also endorse the principles which the United States Representative presented to the United Nations Ad Hoc Committee for adoption by the United Nations General Assembly in order to encourage international cooperation in the scientific investigation of the deep ocean floor, i.e., the bed of the high seas beyond the outer limits of the continental shelf and its subsoil.

These principles would call upon States to (a) disseminate, in a timely fashion, plans for and results of national scientific programs concerning the deep ocean floor; (b) encourage their nationals to follow similar practices concerning dissemination of such information; and (c) encourage cooperative scientific activities regarding the deep ocean floor by personnel of different states.[33]

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[32] See generally, Report of the UN Secretary-General, Marine Science and Technology: Survey and Proposals 74-85, Annex XIII; and Revelle, Man and the Sea in the 21st Century (Unpublished manuscript 1968).

[33] Draft Resolution Containing Statement of Principles Concerning The Deep Ocean Floor, at 4, Press Release USUN-107 (68), June 28, 1968.

Chapter 6 An International Legal-Political Framework for Controlling the Oceans

I. INTRODUCTORY REMARKS

The panel has not had sufficient opportunity to study the problems of oceanic pollution. For this reason, it makes no recommendations to the Commission in this area. However, we thought it might advance public discussion of pollution problems if we attempted a tentative evaluation of the existing framework within which these problems are being handled.

II. OBJECTIVES OF FRAMEWORK

Oil from ships and radioactive substances (deposited in the oceans as a result of radioactive waste disposal or the detonation of nuclear materials to test weapons or for other purposes) constitute the two principal sources of significant oceanic pollution which are generally beyond the power of any single nation to control. The danger of pollution from agents other than oil, resulting from accidents to bulk carriers transporting large quantities of toxic or other dangerous chemicals, may increase in the future.

The framework for controlling oil pollution must assure that all steps technically possible are taken to minimize the discharge of oil from ships that may interfere with uses of the sea other than the transportation of oil.

The Nuclear Test Ban Treaty[1] seeks to stop entirely nuclear weapons testing in the oceans. The oceans, however, continue to be a depository for potentially harmful radioactive substances and this use of the seas may increase in the future. The framework for regulating nuclear pollution must assure that any substantial risk of harm to mankind as a result of this activity will be eliminated, and that this activity does not unreasonably interfere with other uses of the oceans. To these ends, it should specify the conditions under which radioactive waste disposal in the oceans is or is not permissible.

Judged by these criteria, the existing framework is deficient in important respects.

III. EXISTING FRAMEWORK

A. Framework Applicable to Pollution in General

1. Article 2 of the Convention on the High Seas provides generally that the freedoms of the high seas "shall be exercised by all States with reasonable regard to the interests of other States in their exercise of the freedom of the high seas." In this respect, the Convention codified a general principle of international law, but created no implementing machinery.

2. Part II of the Convention on the Territorial Sea and the Contiguous Zone authorizes the coastal State, in a zone of the high seas contiguous to its territorial sea, but extending no farther than 12 miles from the baselines from which the breadth of the territorial sea is measured, to:

> *Prevent infringement of its . . . sanitary regulations within its territory or territorial sea*
>
> *Punish infringement of the above regulations committed within its territory or territorial sea.*

3. The Secretary General of the United Nations has reported that the "investigation and control of marine pollution . . . is a matter on which international action on both regional and global scales is now becoming urgent."[2] Many United Nations organizations are concerned with this problem—the Intergovernmental Maritime Consultative Organization (IMCO), World Health Organization (WHO), Food and Agriculture Organization (FAO), Educational, Scientific and Cultural Organization (UNESCO), and the International Atomic Energy Agency (IAEA). The work of these members of the United Nations family is coordinated

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[1] Done at Moscow, Aug. 5, 1963, entered into force for the United States, Oct. 10, 1963, 14 U.S.T. 1313, T.I.A.S. No. 5433, 480 U.N.T.S. 43. Article I of the Treaty obligates the States Parties not to carry out any nuclear weapon test explosion or any other nuclear explosion in the atmosphere or underwater, including territorial waters or high seas.

[2] Report of UN Secretary General, Marine Science and Technology: Survey and Proposals, E/4487, Apr. 24, 1968, at 83.

by the Sub-Committee on Marine Science and its Applications of the Administrative Committee on Co-ordination (ACC) of the United Nations Economic and Social Council.[3]

FAO, UNESCO (IOC) and IMCO have agreed to establish a Joint Group of Experts on the Scientific Aspects of Marine Pollution.[4] Membership in the Joint Group is open to all other agencies of the United Nations family interested in pollution problems.[5]

B. Framework Applicable to Nuclear Pollution

1. Article 25 of the Convention on the High Seas requires States Parties to:

> *Take measures to prevent pollution of the seas from the dumping of radioactive waste, taking into account any standards and regulations which may be formulated by the competent international organizations; and*
>
> *Cooperate with the competent international organizations in taking measures for the prevention of pollution of the seas or air space above, resulting from any activities with radioactive materials or other harmful agents.*

2. The 1958 United Nations Conference on the Law of the Sea adopted a resolution relating to Article 25 of the Convention on the High Seas, recommending that:

> *The International Atomic Energy Agency, in consultation with existing groups and established organs having competence in the field of radiological protection, should pursue whatever studies and take whatever action is necessary to assist states in controlling the discharge or release of radioactive materials to the sea, in promulgating standards, and in drawing up internationally acceptable regulations to prevent pollution of the sea by radioactive materials in amounts which would adversely affect man and his marine resources.*[6]

In 1958, IAEA convened its first Panel on Radioactive Waste Disposal into the Sea, composed of 11 scientific experts. The Panel published its report in 1959, recommending that IAEA establish an adequate register of disposal of radioactive waste into the sea and consider the legal and organizational measures for international control of radioactive marine disposal.[7]

In 1961, IAEA took three additional steps to discharge its responsibilities. First, it tried to obtain the information on the nature and amount of radioactive waste being released into the sea that was necessary to establish the recommended register, but the response of its member States was inadequate.[8] Then it set up a panel on the Legal Implications of Disposal of Radioactive Wastes into the Sea, which, in 1963, produced two different drafts of a report reflecting the two diverging views on the permissibility of disposing radioactive waste into the sea under general principles of international law.[9] Finally, it established a panel to indicate or devise suitable techniques to survey and monitor the presence of radioactive substances in the sea and marine products.[10] The panel reported in 1962, suggesting standard methods of assessing radioactive contamination levels so that measurements in all parts of the world's oceans may be readily comparable.[11]

3. In Europe, both the European Nuclear Energy Agency and the European Atomic Energy Community (Euratom) are also studying the problems of radioactive waste disposal into the ocean.[12] Euratom has the power to "issue directives to prevent the basic standards [it may establish, by regulation, to assure safe disposal] from being exceeded and to secure compliance with the regulations."

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[3] See generally, *id.*, Annex XIV.

[4] *Id.* at 83.

[5] *Id.*, Annex XIV, at 4.

[6] Document A/Conf. 13/L. 56.

[7] Radioactive Waste Disposal in the Sea, IAEA Safety Series No. 5 (1959).

[8] Report of UN Secretary General, *supra* note 2, Annex XI, at 44-45.

[9] *Id.* at 45. On this question, see also McDougal and Burke, The Public Order of the Oceans 852-68 (1962).

[10] Report of UN Secretary General, *supra* note 2, at 45.

[11] Methods of Surveying and Monitoring Marine Radioactivity, IAEA Safety Series No. 11 (1962).

[12] EURATOM's First General Report 72 (1958).

C. Framework Applicable to Oil Pollution

1. Article 24 of the Convention on the High Seas requires every State Party to:

> *draw up regulations to prevent pollution of the seas by the discharge of oil from ships or pipelines or resulting from the exploitation and exploration of the seabed and its subsoil, taking account of existing treaty provisions on the subject.*

2. Article 5 (1) of the Convention on the Continental Shelf provides:

> *The exploration of the continental shelf and the exploitation of its natural resources must not result in any unjustifiable interference with navigation, fishing or the conservation of the living resources of the sea, nor result in any interference with fundamental oceanographic or other scientific research carried out with the intention of open publication.*

3. Article 5 (7) of the Convention on the Continental Shelf obliges the coastal State to undertake all appropriate measures to protect from harmful agents the living resources of the sea in the safety zones it may establish around installations and other devices it maintains to explore the continental shelf and exploit its natural resources.

4. The International Convention for the Prevention of Pollution of the Sea by Oil[13] is the only existing international agreement dealing exclusively with the prevention and control of marine pollution. At present, 37 countries, including the major maritime nations, are parties to the Convention.

a. Basic Requirements (1.) The Convention imposes the following principal obligations upon member States:

(a.) Article III prohibits the discharge (i.e., any discharge or escape howsoever caused) of oil (including crude oil, fuel oil, heavy diesel oil and lubricating oil) or oily mixture (a mixture with an oil content of 100 parts or more in one million parts of the mixture) from any ship, including a tanker, to which the Convention applies, within any of the prohibited zones referred to in Annex A to the Convention.

The prohibited zones generally are 50-mile zones around the coasts of all countries. In addition, the Convention also specifies a number of prohibited zones of areas considerably in excess of 50 miles. It also authorizes any State Party under certain circumstances, including the absence of objection from any other State Party, to extend its prohibited zone to a maximum of 100 miles from the baselines from which the breadth of its territorial sea is measured.

(*b.*) It requires that the discharge of oil or oily mixture from a ship to which the present Convention applies, other than a tanker, shall be made as far as practicable from land.

(*c.*) Article III prohibits the discharge of oil or oily mixture anywhere at sea from a ship of 20,000 tons gross tonnage or more to which the present Convention applies and for which the building contract is placed on or after the date on which this provision came into force (Dec. 8, 1961, for the United States).

(*d.*) Article VIII requires each State Party to:

> *take all appropriate steps to promote the provision of facilities as follows:*
>
> *according to the needs of ships using them, ports shall be provided with facilities adequate for the reception, without causing undue delay to ships, of such residues and oily mixtures as would remain for disposal from ships other than tankers if the bulk of the water had been separated from the mixture;*
>
> *oil loading terminals shall be provided with facilities, adequate for the reception of such residues and oily mixtures as would similarly remain for disposal by tankers;*
>
> *ship repair ports shall be provided with facilities adequate for the reception of such residues*

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[13] The Convention was signed at London, May 12, 1954. It entered into force for the United States, Dec. 8, 1961, with an understanding, reservations and a recommendation. 12 U.S.T. 2989, T.I.A.S. No. 4900.

To implement the Convention, the Oil Pollution Act of 1961 was passed, Pub. L. 87-167, 75 Stat. 402, 33 U.S.C. §1001-1015 (1961).

The Convention was amended in 1962 by agreement of the States Parties and the provisions of the Convention set forth or described in the text are as amended in 1962. The Oil Pollution Act of 1961 was amended in 1966, Pub. L. 89-551, 80 Stat. 372, to bring it into line with the 1962 Amendments to the 1954 Convention.

and oily mixtures as would similarly remain for disposal by all ships entering for repairs.

Article VIII further requires each State Party to determine which are the ports and oil loading terminals in its territories for the above purposes and to report to IMCO all cases in which the facilities are alleged to be inadequate.

The United States filed an exception to Article VIII.

(*e.*) Article VII requires that each ship covered by the Convention shall be:

so fitted as to prevent, so far as reasonable and practicable, the escape of fuel oil or heavy diesel oil into bilges, unless effective means are provided to ensure that the oil in the bilges is not discharged in contravention of this Convention.

Article VII also calls upon States Parties to avoid carrying water ballast in oil fuel tanks, if possible.

(2.) Article II (1) makes the Convention applicable to:

ships registered in any of the territories of a Contracting Government and to unregistered ships having the nationality of a Contracting Party, except:

tankers of under 150 tons gross tonnage and other ships of under 500 tons gross tonnage, provided that each Contracting Government will take the necessary steps, so far as is reasonable and practicable, to apply the requirements of the Convention to such ships also, having regard to their size, service and the type of fuel used for their propulsion;

ships for the time being engaged in the whaling industry when actually employed on whaling operations;

ships for the time being navigating the Great Lakes of North America and their connecting and tributary waters as far east as the lower exit of St. Lambert Lock at Montreal in the Province of Quebec, Canada;

naval ships and ships for the time being used as naval auxiliaries

Under Article II (2) however, each State Party

undertakes to adopt appropriate measures ensuring that requirements equivalent to those of the present Convention are, so far as is reasonable and practicable, applied to [naval ships and ships for the time being used as naval auxiliaries].

(3.) The Convention provides certain exceptions from its basic requirements:

(*a.*) Article IV makes Article III inapplicable to:

the discharge of oil or of oily mixture from a ship for the purpose of securing the safety of a ship, preventing damage to a ship or cargo, or saving life at sea;

the escape of oil or of oily mixture resulting from damage to a ship or unavoidable leakage, if all reasonable precautions have been taken after the occurrence of the damage or discovery of the leakage for the purpose of preventing or minimizing the escape;

the discharge of residue arising from the purification or clarification of fuel oil or lubricating oil, provided that such discharge is made as far from land as is practicable.

(*b.*) Article V makes Article III inapplicable to the discharge from the bilges of a ship "of oily mixture containing no oil other than lubricating oil which has drained or leaked from machinery spaces."

(*c.*) Article III (b) excepts from its prohibition the discharge of oil or of oily mixture from a ship, other than a tanker, when the ship is proceeding to a port not provided with the facilities referred to in Article VIII of the Convention set forth above.

Partly to offset the impact of this exception, the United States accepted the Convention with the understanding that "Article XI effectively reserves to the parties to the Convention freedom of legislative action in territorial waters, including the application of existing laws, anything in the Convention which may appear to the contrary notwithstanding."[14]

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[14] S. Rep. No. 666, 87th Cong., 1st Sess. 1961, U.S. Code Cong. and Adm. News 2395, 2398 (1961). Article XI of the Convention provides:

Nothing in the present Convention shall be construed as derogating from the powers of any Contracting Government to take measures within its jurisdiction in respect of any matter to which the Convention relates or as extending the jurisdiction of any Contracting Government.

(*d.*) Article III (c) excepts the discharge of oil or oily mixture from ships of 20,000 tons gross tonnage or more "if, in the opinion of the master, special circumstances make it neither reasonable nor practicable to retain the oil or oily mixture on board." In such case, "it may be discharged outside the prohibited zones referred to in Annex A to the Convention." Full details of such discharges must be reported to IMCO at least annually and the reasons for each such discharge must be reported to the State Party to which the ship belongs.

b. Enforcement (1.) Article XII requires each State Party to send to IMCO[15]

> *the text of laws, decrees, orders and regulations in force in its territories which give effect to the present Convention;*
>
> *all official reports or summaries of official reports in so far as they show the results of the application of the provisions of the Convention, provided always that such reports or summaries are not, in the opinion of that Government, of a confidential nature.*

(2.) Article XI (1) and (2) requires every tanker, and every ship which uses oil fuel, covered by the Convention, to be provided with an oil record book, in the form specified in Annex B to the Convention, in which the disposition of oil taken aboard is recorded. The book must be filled in whenever any of the following operations takes place in the ships:

(*a*) ballasting of and discharge of ballast from cargo tanks of tankers;

(*b*) cleaning of cargo tanks of tankers;

(*c*) settling in slop tanks and discharge of water from tankers;

(*d*) disposal from tankers of oily residues from slop tanks or other sources;

(*e*) ballasting, or cleaning during voyage, of bunker fuel tanks of ships other than tankers;

(*f*) disposal from ships other than tankers of oily residues from bunker fuel tanks or other sources;

(*g*) accidental or other exceptional discharges or escapes of oil from tankers or ships other than tankers.

A statement must also be made in the oil record book of the circumstances of, and reason for, the discharge or escape of oil or oily mixture excepted by Article III (c) from the prohibition it otherwise imposes or by Article IV.

Any State Party is authorized to inspect any ship covered by the Convention while it is within any of its ports, as as well as the ship's oil record book from which it may copy any entry.

(3.) Article VI provides:

> *Any contravention of Articles III and IX shall be an offence punishable under the law of the [State Party to which the ship belongs].*
>
> *The penalties which may be imposed under the law of [a State Party in respect of the unlawful discharge from a ship of oil or oily mixture outside the territorial sea of that State Party] shall be adequate in severity to discourage any such unlawful discharge and shall not be less than the penalties which may be imposed under the law of that territory in respect of the same infringements within the territorial sea.*
>
> *Each [State Party] shall report to the Organization the penalties actually imposed for each infringement.*

(4.) Article X provides:

> *Any [State Party] may furnish to the Government [to which a ship covered by the Convention belongs] particulars in writing of evidence that any provision of the present Convention has been contravened in respect of that ship, wheresoever the alleged contravention may have taken place. If it is practicable to do so, the competent authorities of the former Government shall notify the master of the ship of the alleged contravention.*
>
> *Upon receiving such particulars, the Government so informed shall investigate the matter, and may request the other Government to furnish further or better particulars of the alleged contra-*

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[15] IMCO was made the agency responsible for whatever international administration the Convention calls for by IMCO Assembly Resolution A.8(1), June 15, 1959, in accordance with the provisions of Article XXI of the Convention. Fifty-seven nations are now members of IMCO.

vention. If the Government so informed is satisfied that sufficient evidence is available in the form required by its law to enable proceedings against the owner or master of the ship to be taken in respect of the alleged contravention, it shall cause such proceedings to be taken as soon as possible, and shall inform the other Government and [IMCO] of the result of such proceedings.

IV. TENTATIVE EVALUATION OF EXISTING FRAMEWORK

A. Framework Applicable to Nuclear Pollution

At present, there is no effective international regulation of the disposal of radioactive wastes into the sea. There is no international agreement on the conditions under which radioactive waste may be safely disposed into the sea. There is no central register recording information on the nature and amount of radioactive waste being released into the sea. No international agency has been entrusted with responsibility for surveying and monitoring the presence of radioactive substances in the sea and marine products.

The responsibility to prevent harmful radioactive contamination rests entirely with individual nations, assisted in their efforts—when they desire assistance—by IAEA.

Even if it is assumed that the coastal States are authorized by general principles of international law, or Part II of the Convention on the Territorial Sea and the Contiguous Zone, unilaterally to prohibit the disposal of radioactive wastes in a contiguous area, this power is insufficient to handle the problem because it is most improbable that any nation will attempt to dispose of radioactive wastes in areas within the 12-mile limit of any coastal State.

Finally, even if each nation surrounds its own radioactive waste disposal practices with adequate safeguards from its own point of view, the cumulative impact of such practices, followed by each nation without regard for the practices of all other nations, may endanger future uses of the oceans. Article 25 of the Convention on the High Seas merely admonishes the States to cooperate in handling the nuclear pollution problem.

B. Framework Applicable to Oil Pollution[16]

In evaluating the framework applicable to oil pollution, the routine oil spill, i.e., the discharge of oil into the sea that occurs as a result of ordinary ship operation, must be distinguished from the massive oil spill, i.e., the discharge of oil into the sea as the result of accidents to ships occasioned by collisions, foundering and stranding.

1. The Routine Oil Spill

a. General A number of factors cause this discharge of oil into the sea:

(*i*) *Ballasting* Ships empty of cargo lie too high in the water and become very susceptible to the movements occasioned by high wind and rough sea. Sea water or harbor water, therefore, is pumped into tanks of ships to enable them to achieve depth at sea and become more stable and amenable to navigational control. Dry cargo or passenger ships which do not have separate ballasting tanks, which are expensive, usually receive the ballasting water into their fuel tanks. Tankers receive their ballasting water into the same tanks which carry their cargo.

Unless the tanks are cleaned before receiving the ballast water, the mixture of the ballast water with the oil residue creates waste oil emulsion which is the pollutant. The oily water must be discharged before the tankers take on their new cargo or the other ships are refueled.

The problem might be solved by requiring the tanks that will receive the ballast water to be cleaned at the port at which the cargo is unloaded and the wastes discharged into a waste oil facility, but this alternative is apparently very expensive.[17] Instead, the oily water may be discharged into the sea outside the prohibited zones. If the ships are readied for new cargo within a prohibited zone, or they wish to save as much oil as possible, the ballast and tank washings may be gradually run to a single tank while the water is withdrawn from the bottom of the tank after settling. The recovered oil may be discharged ashore at a waste oil terminal or, possibly, retained on the ship and mixed with fresh fuel or the next oil cargo. The clean ballast water may be discharged into the harbor of the loading port.

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[16] This section of the panel report is based upon a paper entitled International Regulation of Oil Pollution prepared for the panel by Professor Thomas A. Clingan, Jr., Professor of Law, The George Washington University and Richard Springer, a student at the Harvard Law School, to whom the panel expresses its thanks.

[17] See generally, Moss, Character and Control of Sea Pollution by Oil 45-46 (American Petroleum Institute, 1963; Moss, A Communication from the American Petroleum Institute to the Chairman of the United States National Committee for Prevention of Pollution of the Seas by Oil 4 (1961).

The prevention of pollution here depends upon the effectiveness of oil-water separators on board ship. The Maritime Administration sponsored a study of such separators which reached the following conclusions:

> *Present devices used in marine service depend entirely on density difference to obtain oil-water separation. Because in the United States the difference in density of fuel oil and water is often small or non-existent, effluents from these separators do not comply with the terms of the Convention. To date, no satisfactory oil-water separator suitable for marine service has been found which will effectively and reliably separate oil and water having essentially the same specific gravity.*
>
> *As a result of this lack of suitable equipment for separating oil or determining the amount of oil in overboard discharge, the ship operator is not in a position to determine whether or not he is violating the Oil Pollution Regulations except by visual observation or catching samples from the discharge line. In the case of a submerged discharge, as used in some vessels, observation is limited to sighting the ship's wake, a method limited to detection of large amounts of oil. These methods are ineffective in that observed oil concentrations above the legal limit are already discharged to the sea. Heavy weather complicates the problem of visual observation and at night there is no means of detection.*[18]

(ii) Cleaning Tankers Tanks of tankers must also be cleaned before they enter shipyards for repairs or take on an entirely different grade of oil. The problems encountered in disposing of the oily water resulting from the cleaning operations are similar to those raised by oily ballast water.

The petroleum industry itself has made significant efforts to control oil pollution. Shell International Marine Limited has proposed a Cleanseas Code which seeks to build a system of control around existing tanker facilities and capabilities. In 1964, the American Petroleum Institute adopted a comprehensive set of policies and procedures to prevent oil pollution, which it explained as follows:

> *Every effort is being made to retain slop oil on board for subsequent discharge ashore into slop receiving facilities or for comingling with future cargoes when this is acceptable to the cargo owner.*
>
> *Oil terminal operators are being encouraged to provide facilities for the reception of slop oil in those cases where the nature of the vessel, its cargo and the trade make such desirable. Methods of minimizing delays incurred as a result of slop disposal are also being adopted by terminals and ship operators.*
>
> *Ship repair yard operators are being informed of the problem and encouraged to provide means for disposing of slop oil from those vessels entering the yard for repair.*
>
> *Installations which have facilities for reception of slop oil are making these facilities available to any vessel calling to load or discharge cargo.*
>
> *In those cases where it is necessary to discharge slop oil at sea, vessel personnel are required by ship-owners to rigidly observe the prohibition zones approved at the 1962 International Oil Pollution Conference. Further, when discharge into permitted areas is necessary, the effluent is put over the side in such a fashion as to promote bacterial oxidation.*
>
> *Operators of vessels under charter are generally requested to follow the same pollution abatement practices as used by vessels of the charter.*
>
> *Where practicable, vessels are being built with independent water ballast system whereby certain tanks and piping are not used alternately for cargo and ballast.*
>
> *Very careful attention is paid to the discharge of cargo to assure that every possible gallon of cargo is removed from the vessel. That remaining is generally collected in a single tank for future discharge ashore.*

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[18] Research and Development for a Shipboard Oil and Water Separation System (The Permutit Company, 1963).

> *Vessel utilization is carefully controlled to minimize the necessity for tank cleaning.*
>
> *Special pollution abatement instructions and informational bulletins are issued to ship's masters. They are required to report on the abatement procedures followed by means of the official Oil Record Book and in many cases on additional company report forms.*[19]

While it is believed that these practices are being followed by most U.S. flag tankers, the number of foreign flag tankers that enter and clear our ports is twice that of the U.S. flag tankers that do so and the foreign flag tankers seem to be less inclined to follow the API recommendations.[20]

b. The Convention for the Prevention of Pollution

(i) Article VIII To make it practical to prohibit the discharge of oil into the sea, Article VIII obligates State Parties to promote the construction of shore facilities to handle waste oil. These facilities would be used primarily by the independent tanker owners who do not own marine terminals and account for approximately three-fourths of the world's tanker fleet.

The United States did not adhere to this Article because it regarded the provision of waste oil disposal facilities on shore as the business of local municipalities, port authorities, oil terminals and private contractors. The United States National Committee for the Prevention of Pollution of the Sea by Oil explained why the United States took this action, even though its waste oil disposal facilities are thought to be well above the world standard:

> *If a foreign vessel were detected discharging oily wastes off the U.S. coast (beyond the three-mile limit), and the government whose flag the ship flies sought to penalize the vessel as the result of a report from the United States, the shipowner might defend himself on the ground that the ship was bound for a U.S. port at which no facility existed. In that event the country of registry presumably would report the ship's statement to the United States authorities making reference to Article VIII, placing the United States in an embarrassing position if in fact no "adequate facility existed in that port."*[21]

(ii) Definition of "oily mixture" This definition in Article I of the Convention is, of course, crucial. There is evidence that a density of 100 parts or more of oil in one million parts of the mixture is unlikely to foul the surface of the water for long or pollute beaches or harm waterfowl, but that higher concentrations would do so.[22] A definition of pollution in such terms makes it very difficult to enforce the Convention "since the strength of the mixture would be impossible to prove without samples."[23]

(iii) Exceptions (*a.*) Making the Convention inapplicable to tankers of under 150 tons and other ships of under 500 tons was intended to exempt thousands of small vessels which would present some countries with enforcement problems they could not administratively handle. Naval ships and auxiliaries were exempted because it was considered inappropriate to subject them to inspection by other authorities. Great Lakes ships were exempted because the problem of pollution in these waters is within the jurisdiction of the International Joint Commission, established under the Boundary Waters Treaty of 1909 between the United States and Canada.[24]

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[19] See Hearings on S. 1591 and S. 1604 Before Subcommittee on Air and Water Pollution of Senate Committee on Public Works, 90th Cong., 1st Sess. 220 (1967).

[20] See Moss, A Communication . . . , *supra* note 17, at 3.

[21] Official Report of United States National Committee for the Prevention of Pollution of the Seas by Oil, Pt II, at 7 (Dept of State, 1959). This Committee was organized in 1956 in furtherance of a recommendation of the London Conference which produced the 1954 convention that Nations should establish national committees to keep the problem of oil pollution under review, to foster research and study and to refer pertinent information to an international clearinghouse. The United States acted on this recommendation even though it had not signed the convention.

The committee is composed of representatives of the interested departments of the Federal government and works closely with private associations interested in the problem.

[22] *Detection of Oil Emissions from Ships at Sea by Observation from Aircraft*, at 10 (A Study Prepared in the United Kingdom by Department of Scientific and Industrial Research, Warren Spring Laboratory, Oct. 1964).

[23] Official Report, *supra* note 21, at 3.

[24] Signed at Washington, Jan. 11, 1909, entered into force May 5, 1910, 36 Stat. 2448, T.S. 548, III Redmond 2607.

(*b.*) It should be noted, too that Article IV's exception of the escape of oil resulting from damage to a ship or unavoidable leakage eliminates to a large extent the application of the Convention to such disasters as the Torrey Canyon.

(iv) Enforcement When it accepted the Convention, the United States recommended amendment of the enforcement provisions (Article VII) of the Convention. The United States National Committee for the Prevention of Pollution of the Seas by Oil has pointed out:

> *Unless uniform penalties are provided, some vessels violating the provisions of the Convention may be able to escape punishment. For instance, in the event that a country does not prescribe effective penalties in its legislation, a vessel under its flag, although cited for discharging oil in a prohibited zone, would not be penalized. Further, some countries might be unable to enforce laws executed consequent to their acceptance of the Convention. Some countries do not now (1959) prescribe any penalties. During the eighteen month period ending in April, 1957, thirty-one foreign vessels of thirteen countries were found by the Coast Guard to have caused oil pollution in U.S. waters. Of the thirteen countries, only three had laws under which their vessels could be penalized.*
>
> *It has been suggested that the Convention might be modified to state that the penalties assessed against violators would be those of the country affected by the violation rather than those of the country of registry of the vessel concerned.*[25]

Sections 6-8 of the Oil Pollution Act of 1961 provide penalties as required by Article XI of the Convention: a fine of not more than $2,500 nor less than $500, or imprisonment for not more than one year, or both. Furthermore, clearance of a ship may be withheld from any United States port until the penalty is paid and the penalty constitutes a lien on such ship recoverable by libel in rem in the district court of the United States for any district within which the ship is found.

In addition, the Coast Guard may take appropriate action against the license of the master or any licensed officer guilty of polluting and, to enforce the Act, may board and inspect any ship in a prohibited zone or in a port of the United States. Punishment for failing to maintain the required oil record book is also prescribed.

Despite these penalties, the Coast Guard has had difficulty enforcing the Act. The vastness of the prohibited zone makes detection a serious problem. Unless the offending vessel is caught in the act of violating the law, it is difficult to determine and assign responsibility. Further, most wilful discharges of oil are done under cover of darkness, making detection next to impossible.

Moreover, it is difficult, if not impossible, to secure convictions in United States courts on the basis of complaints made by foreign countries concerning violation of the Convention in the prohibited zones. Even actual photographs of ships dumping oily wastes have not constituted sufficient evidence; a bottle of the liquid has been required, together with other supporting evidence. There is no reason to assume that United States complaints to foreign governments against foreign ships for violations of the Convention, would not be similarly handled.

Finally, many vessels flying flags of convenience seldom visit their "home" ports where action could be taken. These vessels would appear immune, for all practical purposes, from the Convention.[26]

c. Part II of the Convention on the Territorial Sea and the Contiguous Zone It is questionable whether the "sanitary regulations" referred to in this international Convention include regulations against the pollution of the sea and if they do, whether the authority then conferred upon the coastal State to punish violators of such regulations "within its territory or territorial sea" would extend to punishing a foreign vessel for discharging oil into the sea beyond the 3-mile zone because the oil spreads into the 3-mile zone.

No domestic legislation presently asserts power to punish such an act. In their report to the President in February 1968, the Secretaries of the Interior and Transportation recommended that the

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[25] *Id.* at 5.

[26] *Id.* at 10.

Oil Pollution Act of 1924, should be further amended to assert such a power.[27]

2. The Massive Oil Spill

a. General The most notorious of the recent massive oil spills involved the tanker *Torrey Canyon.*[28] The Barracuda Tanker Company of Bermuda, a subsidiary of Union Oil Company of Los Angeles, California, owned the vessel. For tax purposes, the ship was leased by the subsidiary to the parent company and it was registered in Monrovia and flew the Liberian flag. The crew was Greek and she was on charter to the British Petroleum Company.

On the morning of Saturday, March 18, 1967, she was reported aground on the Seven Stones reef between the Isles of Sicilly and Lands End, England–outside British territorial waters. She had departed Mina Al Ahmadi in the Persian Gulf on February 18, loaded with 119,328 tons of crude oil, shipped by B. P. Trading, Limited, of the United Kingdom, to her destination at Milford Haven, England, by way of the Cape of Good Hope. The grounding was subsequently attributed to the negligence of her master in traversing relatively unfamiliar territory without taking the proper precautions.[29] As a result of this grounding, six tanks were opened, at least in part, to the sea. By Monday, approximately 30,000 tons of crude oil had spilled into the sea and an additional 30,000 tons escaped within a week's time, affecting 100 miles of Cornish beaches.[30] The magnitude of the impact of these spills can be recognized by noting that fifteen tons of crude oil will cover eight square miles of ocean area within a week.[31]

The *Torrey Canyon* was not abandoned, in the sense of maritime law, for some time, so the British government could not legally take immediate charge of the situation.

By March 27, the British Government decided that there was no hope of removing the hulk and ordered the bombing of the tanker in an attempt to burn the remaining oil. The effort was unsuccessful and may have resulted in the release of additional quantities of oil. Efforts were directed at controlling the released fluid with detergents, booms, straw and other materials.[32]

The costs of the disaster are still being counted. 100,000 birds and millions of fish were killed. More than 100 miles of Cornish coast were soaked in an oily slime that washed across the channel to ruin French beaches also. Cleanup costs to the United Kingdom were reported to total $8 million, not including costs to local governments and private agencies.[33] France claimed damages of $7.8 million.[34]

A similar disaster, if it were to pollute the coasts of the United States, would entail staggering costs. It is estimated that a major spill on the beaches of Long Island or in the Los Angeles region could impose losses of revenue from recreational spending alone in the vicinity of $30 million and $51 million respectively.[35]

In May 1967, the IMCO Council met to consider the *Torrey Canyon* disaster and delineated the following areas for further study:

–New means of construction and equipment of ships with a view to limiting the risk of collision or stranding and to avoiding or minimizing the escape of oil, or hazardous or noxious cargoes from ships into the sea as a result of such accidents

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[27] *Oil Pollution, A Report to the President,* A Special Study by the Secretary of the Interior and the Secretary of Transportation, February 1968. For the Oil Pollution Act of 1924, see 33 U.S.C. §§431 *et seg.*, as amended by Pub. L. 89-753, Title II, 80 Stat. 1252 (1966).

[28] There have been other instances but the *Torrey Canyon* disaster will be taken to illustrate the problems involved. For other instances of massive oil spills, see Report to the President, *supra* note 27.

[29] Report of the Board of Investigation in the Matter of the Standing of the S.S. Torrey Canyon, convened by the Government of Liberia, March 18, 1967. Findings and Conclusions 26-28.

[30] Lessons Arising from the Incident of the TORREY CANYON, Note by the United Kingdom.

[31] Rienow, The Oil Around Us, The New York Times Magazine, June 4, 1967, p. 27.

[32] Oil Spillage Study 2-6 (A Report to the United States Coast Guard by Battelle Northwest, Battelle Memorial Institute, 1967).

[33] Report to the President, *supra* note 27, at 4.

[34] New York Times, April 3, 1967, p. 94, col. 1.

[35] Report to the President, *supra* note 27, at 4.

–The possibility of routing merchant ships and providing for traffic separation in certain areas

–Establishment of prohibited areas or areas to be avoided by ships of certain classes and sizes in order to reduce the risk of oil pollution or dangerous cargoes in case of accidents

–International standards of training and certification of officers and crew

–New methods for removal of oil from the sea

–New agents for absorbing or precipitating the oil

–New chemicals and mechanical agents for protecting coastal areas from pollutants, including construction and use of booms, emulsifiers, etc.

–How deliberate marine pollution can be detected in order that it may be penalized

–Extent to which States may take measures of self-protection when threatened or affected by casualties beyond their territorial seas

–Liabilities arising from casualties involving discharge of oil or other substances

–Measures of international cooperation relating to official inquiries and to ship casualties

–Access and use of seaborne salvage equipment of other flags within the territorial waters of states

–Powers of surveillance and control by coastal States to implement measures for strengthening the safety of navigation and obviating marine pollution.[36] To date, IMCO has taken no action or made any recommendation in any of these areas dealing with the technical and navigational aspects of the problem.[37]

b. The Convention for the Prevention of Pollution This Convention contributes little to the solution of the massive oil spill problem.

c. Part II of the Convention on the Territorial Sea and the Contiguous Zone As indicated, there is doubt about the power of the coastal State, under Part II of this Convention, to punish or impose liability upon those responsible for a massive oil spill.

d. General Principles of International Law The IMCO Legal Committee set up a working group to consider the legal issues raised by the *Torrey Canyon* case and, particularly, the following questions submitted to it by the United Kingdom representatives: (1) Under what circumstances may a coastal State take measures to reduce or limit damage? (2) What scope of action should be permitted the coastal State? (3) Should there be prior consultation between the threatened State and the flag State of the offending vessel, or, alternatively, should the threatened State merely be required to give notice of intended action? (4) Under what circumstances should a coastal State be entitled to compensation for the expense of action taken to protect itself? (5) Should the vessel be entitled to compensation for damage done to it in the process?[38]

The Legal Committee Working Group concluded that the coastal state's authority should be limited to casualties of a "major and catastrophic nature." However, it did not agree on whether this authority should be broadly stated to extend to all incidents involving "grave and imminent danger" to coastline, harbors, territorial sea or amenities, or should be limited to incidents involving "dangerous" or "noxious" cargoes listed as such.

The Working Group agreed that when the costal State is authorized to act, it is justified in taking any action to combat the danger, including the bombing of hulks, but the action should be proportionate to the threatened damage and, if not, compensation should be paid to the flag State for the excesses.

The Working Group did not conclude that existing principles of international law permitted the coastal State to take such protective action, but expressed the view that in any case a multilateral agreement dealing with these problems was desirable.

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[36] Summary of Action Taken to Date by IMCO as a Result of the *Torrey Canyon* Disaster, United States Coast Guard Working Paper, Feb. 1, 1968; Report of UN Secretary General, *supra* note 1, Annex XI, at 41-42.

[37] For IMCO's activities with respect to these areas, see Official Report of the United States Delegation to the Fifth Session of the Subcommittee on Safety of Navigation of IMCO, London, March 19-22, 1968, at 5, NAV V/11, April 3, 1968, Annex III.

[38] See IMCO, LEG/WG (I). I/WP. I and LEG/WG (I). I/2.

It is also not clear under existing international law whether the coastal State may recover damages for the costs it incurs to prevent or minimize the threatened damages from a massive oil spill.

Finally, existing admiralty principles of liability based upon fault[39] are inadequate to enable the victims of a massive oil spill to recover damages. Furthermore, even in cases of fault, such recovery may be limited by the provisions of the International Convention Relating to the Limitation of Liability of Seagoing Ships of 1957, to which the United States is not a party, or by the Act for Limitation of Vessel Owner's Liability.[40]

Whether there should be liability to compensate for damages occasioned by a massive oil spill, even in the absence of anyone's fault, whether systems of compulsory insurance should be devised to cover such liability and whether and the extent to which liability should be limited are all questions requiring the most careful consideration.

e. United States Action In the meantime, we are informed by Mr. Max N. Edwards, Assistant Secretary for Water Pollution, Department of the Interior, the President has ordered the most effective system devised to discover and report a pollution incident, stop the spread of oil, clean up and dispose of the pollutants, and institute available legal action to recover cleanup costs. The plans will operate in our inland, coastal and territorial waters, the contiguous zone and the high seas beyond this zone, if a threat exists to United States waters, shores or continental shelf.

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[39] See generally, Gilmore & Black, Admiralty 434-42 (1957).

[40] 46 U.S.C.A. §181-95 (1958).

Appendix A Alternative International Legal-Political Frameworks for Exploring and Exploiting the Mineral Resources of the Deep Seas

I. DIVIDE THE MINERAL RESOURCES OF THE BED OF THE HIGH SEAS AND ITS SUBSOIL AMONG THE COASTAL STATES[1]

a. The following arguments may be adduced in favor of this alternative:

(1) The United States would benefit by this alternative because of Alaska and its long coastlines on the Atlantic and Pacific Oceans and the Gulf of Mexico.

(2) This alternative would perpetuate a familiar pattern by recognizing the exclusive authority of coastal States to lease and protect rights to explore and exploit mineral resources of the sea-bed and subsoil anywhere in the world.

(3) It would thus encourage American private investment enterprise. With respect to resources in the domains allotted to the United States, private companies would probably deal with the Department of the Interior, as they do now for permission to exploit mineral resources on our outer continental shelf. With respect to resources in the domains allotted to other coastal States, private companies would deal with these other nations as they do now. The advantage which American technology now has vis-a-vis the rest of the world and the capital available to American private enterprise for investment would assure American entrepreneurs favorable consideration by other coastal States.

(4) It would benefit most of the nations of the world, since 103 of the 123 UN member-States of the United Nations are coastal States.[2]

(5) It would contribute to international order by eliminating (a) a "race" between nations for access to the bed of the deep seas and the possibility of conflicting claims; (b) problems of deciding which State has jurisdiction to prescribe civil and criminal law applicable to exploration and exploitation of the bed of the deep seas; and (c) conflict-of-law problems.[3]

(6) It would assure coastal States against foreign installation near their shores.

(7) It would avoid all the difficulties connected with the various proposals for international control discussed below.

(8) For all these reasons, it would do most to accelerate exploration and exploitation of the mineral resources of the deep seas.

b. Nevertheless, the panel rejects this alternative because it concludes that it would frustrate American objectives with regard to the use of the oceans.

(1) The United States would not find this alternative acceptable the world over. If islands were given the same rights as continents, which they have under the Continental Shelf Convention, the following results would follow its adoption:[4]

(a) The French would receive a vast area of the Indian Ocean because of Kerguelen, Crozet, and other islands; and a large area of the eastern tropical Pacific, in part because of Clipperton Island, a desolate rock lying about 500 miles southwest of Mexico;

(b) The British would get more than half of the South Atlantic Ocean, because of Ascension, St. Helena, Tristan da Cunha, and South Georgia; and a large share of the North Atlantic, including part of the Blake Terrace, because of Bermuda and the Bahamas;

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[1] This alternative has been advanced by Bernfeld, Developing the Resources of the Sea-Security of Investment, 2 The Int'l Lawyer 67 (1967).

[2] See Marine Science Affairs 1968, Table E-4, at 197-200.

[3] Henkin, *supra* note 38 to Chapter 3, at 60, n. 184.

[4] Christy, Alternative Regimes for the Minerals of the Sea Floor, American Bar Association National Institute on Marine Resources, Long Beach, California, June 8, 1967, at 13, 14.

For a map produced by Mr. Christy showing the division of the floor of the ocean along lines every point of which is equal in distance to the nearest points of adjacent or opposite coastal States, including islands, see Interim Report on the United Nations and the Issue of Deep Ocean Resources of the Subcommittee on International Organizations and Movements of the House Committee on Foreign Affairs, H. Rep. No. 999, 90th Cong., 1st Sess. 89 (1967).

(c) The trust territories of the South Pacific would be practically impossible to divide.

(2) The Soviet Union would get virtually nothing from this "median line" or "national lake" proposal, other than a small slice of the Northwest Pacific, the Barents Sea and the Arctic Ocean.[5] The U.S.S.R. is not likely, therefore, to accept it. Other coastal States which would not gain much from this alternative are also likely to reject it.

(3) This alternative would not be acceptable to the 20 member-States of the United Nations that do not have coastlines.

The fact is that at some point, long before one reaches mid-ocean, the coastal State . . . has no claim greater than that of any other State. Other nations would not see why the coastal States should enjoy the economic and political advantages that exclusive control of these minerals would bring.[6]

(4) While the United States would get a vast section of the North Pacific, its freedom to operate in all oceans would be severely restricted. United States firms would have to deal with a multitude of coastal States, thereby subjecting their investments to the risk of future expropriation and their revenues to increasing royalties and taxes.

(5) In time, there is the danger that this alternative may encourage claims of exclusive coastal State authority over the superjacent waters and the fish therein, the surface waters and the air above them, to the detriment of American interests in the freedom of the seas.[7]

(6) "Even if—as is indeed unlikely—this [alternative] does not lead coastal nations to claim full sovereignty over the areas allotted to them, the uses of the sea and seabed for other purposes would be curtailed. Nations that have control for purposes of exploiting resources would need rights to police and protect their installations, as they have on the continental shelf today. They will begin to impinge on scientific research, fishing, new uses of the seabed for transportation, recreation, sojourn. The United States would be particularly concerned lest such a proposal effectively forecloses the use of most of the oceans for military purposes."[8]

In short, to divide the mineral resources of the seabed and subsoil underlying the high seas among the coastal States of the world would not be consistent with American objectives in the oceans. It would not contribute to the national security or welfare of the United States or to international order or welfare.

II. RECOGNIZE ANY STATE'S CLAIM TO PERMANENT, EXCLUSIVE ACCESS TO THE MINERAL RESOURCES OF PARTICULAR AREAS OF THE BED OF THE DEEP SEAS AND ITS SUBSOIL WHICH THAT STATE IS THE FIRST TO DISCOVER AND EXPLOIT[9]

a. The following arguments may be adduced in favor of this alternative:

(1) It rejects the "median-line" or "national-lake" approach of the first alternative.

(2) International recognition of such national claims would carry with it the right of each State to protect its nationals and other lessees, their installations, equipment and minerals and to create a reasonable safety zone around their operations. Under these circumstances, American private enterprise would feel secure in proceeding with exploration and exploitation.

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[5] Christy, *supra* note 4, at 14.

[6] Henkin, *supra* note 38 to Chapter 3, at 61.

[7] See Craven, *supra* note 83 to Chapter 3, at 34-35; Christy, *supra* note 4, at 14; Chapman, Problems of the North Pacific and Atlantic Fisheries, Annual Meeting, Fisheries Council of Canada, Montreal, May 10, 1967, at 2; Burke, A Negative View of Proposals for United Nations Ownership of Ocean Mineral Resources, American Bar Association National Institute on Marine Resources, June 8, 1967, at II, 10-11; Frosch, *supra* note 84 to Chapter 3, at 8; and Zeni, *supra* note 83 to Chapter 3, at 83. All these government officials and writers agree that the danger adverted to in the text is real.

[8] Henkin, *supra* note 38 to Chapter 3, at 62.

[9] This alternative has been advocated most forcefully by Northcutt Ely, The Administration of Mineral Resources Underlying the High Seas, American Bar Association National Institute on Marine Resources, Long Beach, California, June 8, 1967.

(3) Motivated by economic, military, scientific, technological, prestige and other political considerations and spurred by this alternative, the nations of the world would compete to explore and exploit the mineral resources of the ocean floor. This competition would lead to the earliest possible exploitation of these resources, to the benefit of all mankind.

(4) This alternative is the best legal-political framework that can be devised until such time as the major powers discover minerals in submarine areas which are so close to each other that friction is threatened, or until the major powers are able to produce marine minerals in such profusion as to require an international system of control to balance world production against world demand. At that time, it may be expected, new international law can and would be made with the requisite speed, either by unilateral action, multilateral agreement or United Nations Convention.[10]

b. Nevertheless, the panel concludes that the reasons for rejecting this alternative are compelling.

(1) This alternative will favor the wealthy and technologically advanced nations and prejudice the less developed countries of the world, contrary to the President's declaration that our ocean policy should seek to benefit all mankind. For this reason, it is not a sufficient answer, in our view, to say that the less developed nations may share the benefits by offering their flags as flags of convenience to operators seeking to explore and exploit the mineral resources of the deep seas.[11] Whether to fly a flag of convenience is a decision made, in the first instance, by the nationals of the technologically advanced State, not the less developed country. Moreover, the technologically advanced State has the authority to forbid its nationals to acquire such flags of convenience; it may also have the incentive to do so because "sovereign rights" to the mineral resources of the deep seas constitute a much more important prize than the attribution of national character to ships.

Thus, whatever benefits may flow to a less developed nation from a decision to use its flag for mineral resource exploration and exploitation will come to it not as a matter of right but as a matter of someone else's self-interest.

(2) This alternative may impel a race between nations, if not private entrepreneurs, to appropriate vast areas of the bed of the deep seas and its subsoil for strategic, political or economic reasons, often without regard for cost considerations. Such a race would engender international conflict, contrary to the objectives proclaimed by President Johnson.

(3) Again, there is the danger that possession of the right of permanent, exclusive access to the mineral resources of particular areas of the deep seas may tempt the exploiting State to extend its sovereignty over these areas in all other respects. Even if this temptation is resisted, the right of such permanent, exclusive access would give that State the "opportunity and authority to interfere substantially with free uses of" these ocean areas.[12]

III. ADD TO ALTERNATIVE I OR II CERTAIN "INTERNATIONAL" FEATURES

To make alternative I or II more acceptable to the nations of the world, it may be suggested that every State engaging in exploration and exploitation of the mineral resources of the deep seas, under the alternative chosen, should be required to pay a royalty or tax on the gross revenues or net income from the operations of its licensees; the proceeds from the royalty or tax should be used for agreed upon international purposes.[13] Alternative II might be accompanied by provision for an international registry of claims and an international body to administer the registry and settle disputes.[14]

This suggestion, however, does not obviate remaining serious objections to these alternatives. It would still leave coastal States under alternative I, and the technologically advanced States under alternative II, with the principal economic and political advantages to be derived from control of the mineral resources of the deep seas.[15] Both alternatives, even if amended as suggested, would also continue to hold out grave threats to the freedom of the seas because of the rights to permanent, exclusive access to portions of the bed of the deep seas which they recognize. The panel's own recommendations for an International Registry Authority, as shall be explained, avoids this danger.

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[10] *Id.* at 9.

[11] This argument is made by Burke, *supra* note 7, at 11, 4.

[12] Henkin, *supra* note 38 to Chapter 3, at 63.

[13] See, for example, *id.* at 62.

[14] *Id.* at 64.

IV. GIVE THE UNITED NATIONS, IN THE NAME OF THE INTERNATIONAL COMMUNITY, TITLE TO THE LIVING RESOURCES OF THE SEA BEYOND THE 12-MILE LIMIT AND TO THE MINERAL RESOURCES OF THE BED OF THE HIGH SEAS AND ITS SUBSOIL BEYOND THE OUTER LIMITS OF THE CONTINENTAL SHELF

This proposal has been advanced by the Commission to Study the Organization of Peace (CSOP).[16] In a supplementary paper supporting the proposal, it was suggested that the outer limit of the continental shelf should be redefined to include the bed of the sea and its subsoil to a depth of 200 meters or 100 miles from the baselines for measuring the breadth of the territorial sea, whichever alternative gave the coastal State the greater area for purposes of mineral resources exploitation.[17]

CSOP offered the following, tentative suggestions to implement its basic proposal, acknowledging that many "problems of licensing, control and management of the resources of the sea" would still remain to be solved.

> [CSOP] recommends that there should be established a special agency of the United Nations to be called the United Nations Marine Resources Agency. *It should control and administer international marine resources; hold ownership rights; and grant, lease or use these rights in accordance with the principles of economic efficiency. It should function with the independence and efficiency of the International Bank. However, it should distribute the returns from such exploitation in accordance with directives issued by the United Nations General Assembly.*[18]

Thus, CSOP envisaged that the United Nations agency might not only license the exploration and exploitation of the marine resources beyond the continental shelf, but might itself engage in such exploration and exploitation. It also contemplated that the revenues from licensing or operation would be used to provide the United Nations with an independent source of income.[19] However, Dr. Francis J. Christy has also proposed that in order to make his suggested redefinition of the continental shelf acceptable to the coastal States, the royalties, fees, taxes or rents paid to the United Nations agency might be split with the nearest coastal State. The closer to shore the exploration and exploitation, the higher the share of the coastal State; the farther from shore, the higher the share of the United Nations agency.[20]

The United Nations Charter Committee of the World Peace Through Law Center endorsed the essentials of the CSOP proposals when it recommended to the 1967 Geneva World Peace Through Law Conference that the United Nations General Assembly issue a proclamation declaring that the high seas appertain to the United Nations and are subject to its jurisdiction and control.[21]

At this point we wish to deal only with certain aspects of the CSOP proposals.

a. *Desirability of a single legal-political framework for all uses of the oceans.* It should be noted, first, that the CSOP proposals treat together the living (fisheries), as well as the non-living (minerals), resources of the oceans. In support of this view, it may be argued that a single international legal-political framework for the totality of ocean uses is essential to solve the problem of conflicting uses and that the CSOP recommendations embody the most efficient single framework.

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[15] *Id.* at 62.

[16] See New Dimensions for the United Nations, CSOP Seventeenth Report, at 36-41, 135-170 (1966).

[17] Christy and Brooks, Shared Resources of the World Community, in CSOP Seventeenth Report, at 160.

[18] CSOP Seventeenth Report, at 39 (original emphasis).

[19] *Id.* at 38.

[20] Christy, *supra* note 4, at 20.

[21] 1967 Report of the United Nations Charter Committee of the World Peace Through Law Center, at 6.

Without minimizing the problem of conflicting uses, which may become accentuated as the uses of the sea multiply, it is the panel's judgment that it would not be wise, at this stage of the development of ocean's resources, to seek a single legal-political framework for all uses. Different frameworks are needed for the rational exploitation of the different ocean resources. To give the United Nations title to all the ocean's resources will not, by itself, solve the problem of conflicting uses, nor do we think that it will make the problem so much easier as to warrant its acceptance for that reason alone.

It is interesting in this connection that the 1967 Geneva World Peace Through Law Conference rejected the recommendation of its United Nations Charter Committee for a single legal-political framework for the exploitation of the resources of the high seas. Instead, the Conference recommended that the United Nations General Assembly issue "a proclamation declaring that the *non-fishery resources* of the high seas, outside the territorial waters of any state, and the bed of the sea beyond the continental shelf, appertain to the United Nations and are subject to its jurisdiction and control." The Conference referred to its Committee on Fisheries Law "the question of conservation and regulation of the international fishery resources of the high seas."[22]

b. *Exploitation of ocean resources as an independent source of income for the United Nations.* It is argued persuasively that the cause of peace in the world will be advanced if the United Nations has access to an independent source of income for its general purposes. This would "render moot the recent differences about financing that have threatened the existence of the organization"; "relieve the burden on individual members, especially on the United States, the largest contributor to all UN budgets"; and "give the UN the means to perform its various functions, especially maintaining the peace."[23]

Nevertheless, it is the panel's considered view that the question of the appropriate international legal-political framework for the exploitation of the resources of the deep seas should not be linked to, let alone controlled by, the assumed need of the United Nations for an independent source of income for its general purposes. Such a linkage would multiply the difficulties of securing international agreement upon any new framework. If the nations of the world—particularly the big powers—agree that the United Nations needs an independent source of income, they can satisfy the need in other ways.

c. *Arms control.* In Chapter 1, the panel stated its view that the bed of the deep seas and its subsoil should not be used for the emplacement of weapons of mass destruction, but that this issue should be considered in the larger arms control context and not as part of an "ocean package."

Proposals like that made by the United Nations Charter Committee of the World Peace Through Law Center to give the United Nations title to the high seas might have the consequence that any use, including any military use, of the high seas would have to be authorized by the designated United Nations agency. This proposal, together with CSOP's sweeping recommendation that there should be a United Nations General Assembly declaration, followed by international agreement, that "the deep sea and the seabed must not be used by nations as an environment in which to install or operate weapons, or for purposes intended to further research on potential weapons or their development,"[24] might jeopardize the security of the United States without advancing the cause of peace.

It would not enhance our national security or promote peace if, for example, the United States were required, as part of a legal-political framework for the exploitation of marine resources, to seek the permission of a United Nations agency in order to continue to operate mobile submersible nuclear weapon systems in the deep seas or to install fixed equipment on sea mounts or the seabed for navigation or identification and surveillance of submersibles and other types of warships. The military uses of the oceans contribute significantly to the present condition of mutual strategic deterrence of the

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[22] Geneva World Peace Through Law Conference, Resolution 15, Resources of the High Seas, adopted July 13, 1967 (emphasis added).

[23] Henkin, *supra* note 38 to Chapter 3, at 56. See also, CSOP Seventeenth Report, at 38-39.

[24] CSOP Seventeenth Report, at 40-41.

Soviet Union and the United States. The United States should not forego such uses *except in the context of a broader agreement for arms control and disarmament.*

d. A United Nations agency monopoly. Under the comprehensive CSOP proposal, the United Nations agency which holds "ownership rights" to the marine resources might itself elect to engage in the exploitation of the resources, contracting for the use of the necessary machinery and equipment and the services of necessary personnel. It might thus exclude all States and their nationals from engaging in such exploitation other than as contractors.

The panel concludes that such a monopoly would be undesirable. It is not the most efficient way to encourage the development of the ocean's resources. It would force the United Nations agency to compete, in marketing the resources in question, with private entrepreneurs and state-traders on land. Clearly, it would not help to attain the objective of the Marine Resources and Engineering Development Act to encourage "private investment enterprise in exploration, technological development, marine commerce, and economic utilization of the resources of the marine environment."

For the same reasons, the panel would oppose such an international monopoly even if it were not put in the hands of a United Nations agency but in an international consortium independent of the United Nations, whether entirely intergovernmental, entirely private or mixed.

V. GIVE THE UNITED NATIONS, IN THE NAME OF THE INTERNATIONAL COMMUNITY, "TITLE" TO THE MINERAL RESOURCES OF THE BED OF THE HIGH SEAS AND ITS SUBSOIL BEYOND THE LIMITS OF THE CONTINENTAL SHELF

A proposal for United Nations control has been made which would obviate the objections advanced above to the more inclusive CSOP recommendations.[25] Under this proposal, the United Nations would take "title" only to the mineral resources of the deep seas. However, "title" would give the designated United Nations agency authority only to prohibit all exploration and exploitation of the mineral resources of the deep seas except by its prior license and to auction to the highest bidder such licenses, i.e., the exclusive rights to explore and exploit specified mineral resources in particular areas of the deep seas. It would not give the agency itself authority to explore and exploit the mineral resources and exclude all States and their nationals from engaging in such exploration and exploitation.

Revenues from such United Nations licensing would be used for internationally agreed purposes–e.g., to combat protein malnutrition all over the world–but not to give the United Nations an independent source of income for its general purposes.

a. The arguments for such an international legal-political framework are many.

(1) In the first place, it would avoid the difficulties of the alternatives previously considered.

(2) It would accomplish the prime objective of any international framework: to prevent a race among nations to claim the bed of the deep seas which might interfere with other uses of the seas and provoke controversy, tension, and conflict.

(3) It would raise revenues from the exploitation of the mineral resources of the deep seas that would be used for the benefit of all mankind.

(4) It would promote "a more integrated world system governed in such a way that a general public interest can be established and made the basis for global resources policies."[26]

(5) It would protect the investments of exploring and exploiting States and private entrepreneurs because the United Nations agency would be able to assure licenses for a sufficiently large area and a sufficiently long time to make possible an economically efficient and profitable operation. American private entrepreneurs would have an opportunity under this framework to explore and exploit the

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[25] The proposal that follows is essentially that of Christy, *supra* note 4. See also Christy, A Social Scientist Writes to the International Lawyer on Economic Criteria for Rules Governing the Exploitation of Deep Sea Minerals, 2 The International Lawyer 224 (1968). The arguments in favor of the proposal are also largely Mr. Christy's.

[26] Cheever, The Role of International Organizations in Ocean Development 3, The Ohio State University, Mershon-Carnegie Endowment Conference on Law, Organization and Security in the Use of the Oceans, October 6, 1967.

mineral resources of all the deep seas. They "would be secure against nationalization or increased taxes and royalties, and insulated from the vagaries of political climate (e.g., in the Middle East, or in Nigeria today)."[27]

(6) Furthermore, this framework will make it possible to solve one of the principal problems that may arise in connection with the commercial exploitation of manganese nodules. Because the capital costs of such exploitation are likely to approximate at least $100 million and technological requirements will be high, as will be the risks, the number of producers will probably be small in the foreseeable future. To earn a satisfactory return on his investment, the producer will have to control a large area, estimated from at least 1,000 square miles up to 30,000 square miles. Particular sites are likely to vary greatly in value because of wide differences in the density of the nodules on the seabed, their metallic content, the depth of water in which they lie, the topography of the floor, etc. Competition for access to the more valuable sites may be severe. The estimated reasonable scale of production of even a single enterprise will be very large—so large as to cause significant reductions in the prices of manganese, cobalt and nickel. Two or three producers would have even greater effect. In the short-run, these few producers would have difficulty in controlling the rate of output in relation to the market for their products.

The United Nations agency, however, would have authority to limit the number of entrants and thereby prevent excessively rapid rates of output that would depress prices and revenues to all producers.

(7) The proposed framework would also contribute effectively to the solution of the problem of conflicting uses because the United Nations agency would have power to withhold areas from exploration and exploitation in the interest of more important conflicting uses, a step no nation would be willing to take unilaterally.

(8) For all these reasons, it is finally argued, the proposal would be most acceptable to the nations of the world.

b. The panel has given this alternative its most careful consideration. Many of the arguments in its favor are persuasive, but the panel concludes that it would be unwise to accept this alternative because it would not accomplish its aims.

(1) The auctioning to the highest bidder of exclusive rights to explore and exploit the mineral resources of particular areas of the bed of the deep seas is the heart of the proposal. We do not think this procedure is likely to result in the most economically efficient operations or minimize conflict and rivalry among nations. Nations are likely to bid for political, technological, prestige or security reasons or for purposes of economic warfare. Such bidding would raise the prices of the resources in question wholly apart from cost considerations, yet it should be a world objective to make the resources available to mankind at the lowest possible prices. Furthermore, since some bidders may be States and others may be private entrepreneurs, it is difficult to see that economic rationality would necessarily be reflected in their competitive bidding.

(2) These difficulties would be compounded if the United Nations agency undertook to limit entry in order to forestall too rapid increases in output and decreases in price, because then the bidding for the initial licenses would become fiercer. Moreover, limiting entry alone would not accomplish the hoped-for objectives unless the supply brought to market by the limited number of producers was also regulated. Under the assumed conditions, mineral prices could be prevented from becoming unduly depressed only by an international monopoly (created by the exclusive operation of a single international agency or the auctioning of exclusive rights to explore and exploit manganese nodules on the beds of all the deep seas to a *single* high bidder) or an international cartel composed of two or more producers licensed by the United Nations agency. Neither of these alternatives is desirable, but a cartel is to be preferred over a monopoly. The cartel "solution" will be available, if needed, under the international legal-political framework which the panel recommends and which does not authorize any international agency to auction licenses or limit entry.

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[27] Henkin, *supra* note 38 to Chapter 3, at 65.

(3) Decisions by the United Nations agency whether or not to open up particular areas of the deep seas to mineral resource development, in view of the conflicting uses of the areas in question, may be made on the basis of the degree of control the agency wishes to exercise over these other uses–surface and undersea navigation, submarine pipelines and cables, fishing, recreation, pollution control, military exercises and installations, and scientific inquiry. This is a very far-reaching authority which may provoke conflicts between States and the United Nations authority.

(4) Finally, even if it is assumed that the United Nations agency is able to attract the kind of personnel this alternative would require–an assumption many dispute–acceptance of this alternative at this time "might be so revolutionary as to be disruptive of evolutionary processes."[28] In any case, the controversy that would undoubtedly accompany efforts to establish such a United Nations agency would delay exploration and exploitation of the mineral resources of the deep seas and no agreement might be reached. Such an eventuality would weaken the United Nations' "capacity to play a more modest and hence more feasible role."[29]

VI. SENATOR PELL'S PROPOSED TREATY ON PRINCIPLES GOVERNING THE ACTIVITIES OF STATES IN THE EXPLORATION AND EXPLOITATION OF OCEAN SPACE[30]

On March 5, 1968, Senator Claiborne Pell of Rhode Island introduced a resolution that it was the "sense of the Senate" that the President should seek to negotiate an international treaty on the peaceful exploration and exploitation of ocean space. Parts I and II of the proposed Treaty set forth certain general principles which are similar, in many respects, to the principles presented by the United States to the United Nations Ad Hoc Committee and with which our Panel is in accord. It should be pointed out that the statement made by the United States makes explicit, as the proposed Treaty does not, that no State may claim "sovereign rights" (or "sovereignty") over any area of the bed of the deep seas or its subsoil.

The provisions of the Treaty regarding exploration and exploitation of mineral resources follow:

Part III–Use of Sea Bed and Subsoil of Ocean Space

Article 12

In order to promote and maintain international cooperation in the peaceful and orderly exploration, and exploitation of the natural resources, of the seabed and subsoil of submarine areas of ocean space, each State Party to the Treaty undertakes to engage in such exploration or exploitation only under licenses issued by the licensing authority to be designated by the United Nations, with approval by the Security Council in the manner provided by paragraph 3 of Article 27 of the Charter of the United Nations.

Article 13

The natural resources referred to in this Part consist of the mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil.

Article 14

The activities of nationals and non-governmental entites in the exploration of submarine areas of ocean space and the exploitation of the natural resources of such areas shall require authorization and

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[28] Cheever *supra* note 26, at 5.

[29] *Id.* at 21.

[30] S. Res. 263, 90th Cong., 2d Sess., 114 Cong. Rec. S. 2199 (daily ed., March 5, 1968). In the main, this resolution puts in treaty form the principles which Senator Pell had previously proposed for adoption by the United Nations General Assembly. See S. Res. 186, 90th Cong. 1st Sess., 113 Cong. Rec. S. 16646 (daily ed., Nov. 17, 1967).

continuing supervision by the appropriate State Party to the Treaty, and shall be conducted under licenses issued to States Parties to the Treaty making application on behalf of their nationals and non-governmental entities. When such activities are to be carried on by an international organization, a license may be issued to such organization as if it were a State.

Article 15

It shall be the duty of the licensing authority referred to in Article 12 to act as promptly as possible on each application for a license made to it. In issuing licenses and prescribing regulations, the licensing authority shall apply all relevant provisions set forth in this Treaty and shall apply the following criteria:

(a) The license issued by the licensing authority shall (i) cover an area of such size and dimension as the licensing authority may determine, with due regard given to providing for a satisfactory return of investment, (ii) be for a period of not more than fifty years, with the option of renewal, provided that operations are conducted with the approval of the licensing authority, (iii) require the payment to the licensing authority of such fee or royalty as may be specified in the lease, (iv) require that such lease will terminate within a period of not more than ten years in the absence of operations thereunder unless the licensing authority approves an extension of the period of such license, and (v) contain such other reasonable requirements as the licensing authority may deem necessary to implement the provisions of this Treaty and to provide for the most efficient exploitation of resources possible, consistent with the conservation of and prevention of the waste of the natural resources of the seabed and subsoil of ocean space.

(b) If two or more States Parties to the Treaty apply for licenses to engage in the exploration of the seabed and subsoil of ocean space or the exploitation of its natural resources in the same area or areas of ocean space, the licensing authority shall, to the greatest extent feasible and practicable, encourage cooperative or joint working relations between such States and be guided by the principle that ocean space shall be free for use by all States, without discrimination of any kind, on a basis of equality of opportunity. But, if it proves impractical for the license to be shared the licensing authority shall determine which State Party to the Treaty shall receive the license with due regard given to the encouragement of the development of the technologically developing States.

(c) A coastal State has a special interest in the conservation of the natural resources of the seabed and subsoil of ocean space adjacent to its territorial sea and continental shelf and this interest shall be taken into account by the licensing authority.

(d) A coastal State is entitled to take part on an equal footing in any system of research and regulation for purposes of conservation of the natural resources of the seabed and subsoil of ocean space in that area, even though its agencies or nationals do not engage in exploration there or exploitation of its natural resources.

(e) The exploration of the seabed and subsoil of ocean space and the exploitation of its natural resources must not result in any unjustifiable interference with navigation, fishing, or the conservation of the living resources of the sea, nor result in any interference with fundamental oceanographic or other scientific research carried out with the intention of open publication.

(f) A State or international organization holding a license is obliged to undertake, in the area covered by such license, all appropriate measures for the protection of the living resources of the sea from harmful agents and shall pursue its activities so as to avoid the harmful contamination of the environment of such area.

Article 16

1. Subject to appropriate regulations prescribed by the licensing authority referred to in Article 12 and to the following provisions, a State or international organization holding a license shall be entitled to construct and maintain or operate on the seabed and subsoil of ocean space installations and other *devices necessary for its exploration and the exploitation of its natural resources, and to establish safety zones around such installations and devices and to take in those zones measures necessary for their protection.*

2. The safety zones referred to in this article may extend to a distance of 500 meters radius around the installations and other devices which have been erected, measured from each point of their outer edge. Ships of all nationalities must respect these safety zones.

3. Such installations and devices do not possess the status of islands and have no territorial sea of their own.

4. Due notice must be given of the construction of any such installations, and permanent means for giving warning of their presence must be maintained. Any installations which are abandoned or disused must be entirely removed by the State or international organization responsible for their construction.

5. Neither the installations or devices, nor the safety zones around them, may be established where interference may be caused to the use of recognized sea lanes essential to international commerce and navigation.

Article 17

To the greatest extent feasible and practicable, the licensing authority referred to in Article 12 shall disseminate immediately and effectively information and data received by it from license owners regarding their activities in ocean space.

Article 18

If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals or non-governmental entities under a license issued pursuant to this Part would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and exploitation of ocean space, it shall undertake appropriate international consultations and obtain the consent of the licensing authority referred to in Article 12 before proceeding with such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party would cause potentially harmful interference with activities in the peaceful exploration and exploitation of submarine areas of ocean space may request consultation concerning the activity or experiment and submit a request for consideration of its complaint to the licensing authority, which may order that the activity or experiment shall be suspended, modified, or prohibited. Review of any such order shall be allowed in accordance with the provision of Article 23.

Article 19

All stations, installations, equipment, and sea vehicles, machines, and capsules used on the seabed or in the subsoil of ocean space, whether manned or unmanned, shall be open to representatives of the licensing authority referred to in Article 12, except that if there is objection to this procedure by the licensee, such facilities shall be open only to the Sea Guard of the United Nations as set forth in Article 26 of this Treaty.

Article 20

Whenever a State Party to the Treaty or an international organization fails to comply with any of the provisions of a license issued to it under this Part, such license may be canceled by the licensing authority referred to in Article 12, upon thirty days notice to the State or international organization concerned, but subject to the right of the license owner to request review of the decision of the licensing authority as set forth in Article 23.

Article 21

Any dispute which may arise under this Part between States or international organizations holding licenses, or between license owners and the licensing authority referred to in Article 12, shall first be submitted for settlement by the licensing authority, which shall determine its own procedure, assuring each party a full opportunity to be heard and to present its case.

Article 22

In all cases of disputes under this Part, whether among license owners or between license owners and the licensing authority referred to in Article 12, the licensing authority shall be empowered to make awards.

Article 23

1. In the case of any dispute under this Part, if the licensing authority shall not have rendered its decision within a reasonable period of time or if any party to a dispute under this Part desires review of the decision of the licensing authority, such dispute shall, at the request of any of the parties, be submitted to a standing review panel which shall consist of not more than three members to be appointed by the International Court of Justice. The decision of the licensing authority shall be final and binding upon all parties to a proceeding before it unless a request for a review of such decision is made under this Article within a period of thirty days from receipt by such parties of notice of such decision.

2. No two members of the panel may be nationals of the same State. No member may participate in the decision of any case if he has previously taken part in such case in any capacity or if he is a national of any party involved in the case.

3. Members of the panel shall serve at the pleasure of the International Court of Justice. The Court shall fix the salaries, allowances, and compensation of members of the panel. The expenses of the panel shall be borne by each party to proceedings before the panel in such a manner as shall be decided by the Court.

4. The panel shall determine its own procedure, assuring each party to the proceeding a full opportunity to be heard and to present its case.

5. It shall be the duty of the panel to hear and determine each case as promptly as possible. The decision of the panel shall be by majority vote and shall be final and binding upon the parties to the proceedings; except that if any party to the proceeding desires review of the decision, the case shall be within the compulsory jurisdiction of the International Court of Justice as contemplated by paragraph 1 of Article 36 of the Statute of the International Court of Justice, and may accordingly be brought before the Court by an application made by such party.

Part IV–Use of Seabed and Subsoil of Ocean Space for Peaceful Purposes Only

Article 24

1. The seabed and subsoil of submarine areas of ocean space shall be used for peaceful purposes only.

2. The prohibitions of this Part shall not be construed to prevent–

(A) the use of military personnel or equipment for scientific research or for any other peaceful purpose;

(B) the temporary use or stationing of any military submarines on the seabed or subsoil of ocean space if such submarines are not primarily designed or intended for use or stationing on the seabed or subsoil of ocean space; or

(C) the use or stationing of any device on or in the seabed or subsoil of ocean space which is designed and intended for purposes of submarine or weapons detection, identification, or tracking.

Article 25

1. Each of the States Parties to this Treaty undertakes to refrain from the emplacement or installation on or in the seabed or subsoil of ocean space of any objects containing nuclear weapons or any kinds of weapons of mass destruction, or the stationing of such weapons on or in the seabed or subsoil of ocean space in any other manner.

2. Each of the States Parties to this Treaty undertakes furthermore to refrain from causing, encouraging, or in any way participating in the conduct of the activities described in paragraph 1 of this Article.

Article 26

All stations, installations, equipment, and sea vehicles, machines, and capsules, whether manned or unmanned, on the seabed or in the subsoil of ocean space shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity, but only with the consent of the State concerned. Such representatives shall give reasonable advance notice of a projected visit in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited. All such facilities shall be open at any time to the Sea Guard of the United Nations referred to in Part VII of this Treaty, subject to the control of the Security Council as set forth in such Part.

Part V–Regulations on the Disposal of Radioactive Waste Material in Ocean Space

Article 27

The disposal of radioactive waste material in ocean space shall be subject to safety regulations to be prescribed by the International Atomic Energy Agency, in consultation with the licensing authority referred to in Article 12 of this Treaty.

Article 28

In the event of the conclusion of any other international agreements concerning the use of nuclear energy, including the disposal of radioactive waste material, to which all of the States Parties to the Treaty are parties, the rules established under such agreements shall apply in ocean space.

Part VI–Limits of Continental Shelf

Article 29

In order to assure freedom of the exploration and exploitation of ocean space and its resources as provided in this Treaty, there is a clear necessity that fixed limits must be set for defining the outer boundaries of the continental shelf of coastal States. For the purpose of the provisions of this Treaty, the term "continental shelf" is used as referring (a) to the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea to a depth of 600 metres, and (b) to the seabed and subsoil of similar submarine areas adjacent to the coasts of islands. Recognizing the desirability of achieving agreement on unsettled questions relating to defining the boundaries of the continental shelf, States Parties to the Treaty undertake to accept any agreements which may be reached in the event a conference is convened to consider such questions as provided for in Article 13 of the Convention on the Continental Shelf, adopted at Geneva on 29 April 1958; and any agreement so reached shall become effective for purposes of this Treaty when approved by the conference.

Part VII–Sea Guard

Article 30

In order to promote the objectives and ensure the observance of the provisions set forth in this Treaty, States Parties to the Treaty agree that there shall be established as a permanent force a Sea Guard of the United Nations which may take such action as may be necessary to maintain and enforce international compliance with these principles.

Article 31

The Sea Guard shall be under the control of the Security Council of the United Nations, in consultation with the licensing authority referred to in Article 12 of this Treaty. Paragraph 3 of Article 27 of the Charter of the United Nations shall be applicable to decisions of the Security Council made with respect to the Sea Guard. The licensing authority shall be responsible under the Security Council for the supervision of the Sea Guard in connection with the performance by the Sea Guard of such duties as the licensing authority may deem appropriate to assign or delegate to the Sea Guard for purposes of the implementation of Part III of this Treaty.

Article 32

States Parties to the Treaty are encouraged to provide to the Sea Guard such personnel and suitable scientific and sea patrol vessels as are necessary for the establishment and maintenance of the Sea Guard.

Part VIII–National Laws to Apply to Crimes in Ocean Space Pending International Agreement on Code of Criminal Law

Article 33

Pending agreement upon an international code of law governing criminal activities in ocean space and the installation of an appropriate tribunal with jurisdiction over violations of such code of law, personnel of States Parties to the Treaty and non-governmental entities of States Parties and international organizations engaged in activities of exploration or exploitation in ocean space shall be subject only to the jurisdiction of the State of which they are nationals or the State which bears responsibility for their activities in respect of all acts or omissions occurring while they are in ocean space, unless otherwise provided for by international law or in this Treaty.

It should be noted that the proposed Treaty would redefine the continental shelf, for its purposes, to include "(a) . . . the seabed and subsoil of the submarine areas adjacent to the territorial sea to a depth of 600 meters, and (b) . . . the seabed and subsoil of similar submarine areas adjacent to the coasts of islands." Nevertheless, this recommendation does not seem to be hard and fast, for the Treaty would also commit the States which become parties to it to accept any redefinition negotiated as a result of a request for revision of the Convention on the Continental Shelf. No suggestion is made, however, as to how the continental shelf should be redefined in the event an international conference is convened for this purpose.

It is also difficult to evaluate the provisions for licensing in the proposed Treaty. While the Treaty makes clear that each State Party undertakes to engage in mineral resources exploration or exploitation only under licenses issued by the designated international licensing authority, it does not state explicitly whether the licensing authority may deny an application for a license made to it by a State Party. The provisions of the Treaty regarding competing applications, however, may imply that in all other cases the licensing authority must grant every application. In any case, it is clear that the licensing authority would have extensive powers to impose conditions upon licensed operations.

Finally, the arms control provisions of the proposed Treaty go further in imposing limitations upon the military use of the bed of the deep seas, and its subsoil than those which the United States has urged upon the United Nations Ad Hoc Committee.

As will be seen, the panel's recommendations accept some of the elements of the proposed Treaty, but not others.

Appendix B The Principal Treaties and Other International Agreements Relating to Fisheries to Which the United States Is a Party

I. MULTILATERAL AGREEMENTS TO WHICH UNITED STATES IS A PARTY

A. The Convention on Fishing and Conservation of the Living Resources of the Sea[1]

1. Objectives

The Convention declares that all States have (1) the right for their nationals to engage in fishing on the high seas subject to (a) their treaty obligations, (b) the interests and rights of coastal states as provided for in the Convention and (c) the provisions contained in the Convention concerning conservation of the living resources of the high seas; and (2) the duty to adopt, or to cooperate with other States in adopting necessary conservation measures.[2] By "conservation of the living resources of the high seas," the Convention means "the aggregate of the measures rendering possible the optimum sustainable yield from those resources so as to secure a maximum supply of food and other marine products."[3] Conservation programs are to be formulated "with a view to securing in the first place a supply of food for human consumption."[4]

The States Parties to the Convention are: Australia, Cambodia, Colombia, Dominican Republic, Finland, Haiti, Jamaica, Madagascar, Malawi, Malaya, Mexico, Netherlands, Nigeria, Portugal, Senegal, Sierre Leone, South Africa, Switzerland, Trinidad and Tobago, Uganda, United Kingdom, United States, Upper Volta, Venezuela, and Yugoslavia.

2. Substantive Provisions

The Convention imposes an obligation upon a State to adopt needed conservation measures in any area of the high seas in which its nationals alone are engaged in fishing.[5] If the nationals of two or more States are engaged in fishing the same stock of fish in any area of the high seas, any of the States may request the others to enter into negotiations looking to an agreement on the conservation measures that should be adopted.[6] The Convention requires the States to enter into such negotiations and provides that if they do not reach agreement within 12 months, any one of them may invoke the dispute settlement machinery described below.[7]

If conservation measures are adopted and, subsequently, the nationals of other States enter the fishery, the other States are obligated to apply the measures, provided they do not discriminate against their nationals.[8] In the event of a failure to discharge this obligation, any other State in the fishery may invoke the dispute settlement machinery,[9] but the conservation measures remain obligatory pending the final decision of the arbitration agency, unless the agency supersedes them in the interim.[10]

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[1] See note 36 to Chapter 3, *supra.* The United States Senate ratified the Convention on May 26, 1960, subject to the "understanding" that it would not be construed "to impair the applicability of the principle of 'abstention' . . . ." The Convention became effective for the United States in 1966, TIAS No. 5969.

[2] Convention, Art. 1.

[3] *Id.*, Art. 2.

[4] *Ibid.*

[5] *Id.*, Art. 3.

[6] *Id.*, Art. 4 (1).

[7] *Id.*, Art. 4 (2).

[8] *Id.*, Art. 5 (1).

[9] *Id.*, Art. 5 (2).

[10] *Ibid.*

The Convention also recognizes the "special interest" of the coastal State "in the maintenance of the productivity of the living resources in any area of the high seas adjacent to its territorial sea."[11] Accordingly, it gives the coastal State the right to (1) "take part on an equal footing in any system of research and regulation for purposes of conservation of the living resources of the high seas in that area, even though its nationals do not carry on fishing there;"[12] and (2) request any State, whose nationals are engaged in fishing in that area, to enter into negotiations looking to agreement on the necessary conservation measures.[13]

If agreement is not reached within six months of the opening of the negotiations, the coastal State may "adopt unilateral measures of conservation appropriate to any stock of fish" in the area.[14] These measures shall be valid as to other States only if (a) there is a need for urgent application of conservation measures in the light of the existing knowledge of the fishery; (b) the measures adopted are based on appropriate scientific findings; and (c) they do not discriminate in form or fact against foreign fishermen.[15]

No State whose nationals are fishing in that area shall enforce conservation measures therein which are opposed to those adopted by the coastal State.[16] However, if the coastal State's measures are not accepted by the other States concerned, any one of them may invoke the dispute settlement machinery to test their validity.[17] The measures remain obligatory upon the other States unless the arbitration agency suspends them pending the outcome of the proceedings before it.[18]

If the coastal State does not adopt conservation measures unilaterally and no agreement on such measures is reached within 12 months after the opening of negotiations requested by the coastal State, any of the States concerned may invoke the dispute settlement machinery.[19]

Even if its nationals are not engaged in fishing in an area of the high seas *not* adjacent to its coast, any State which has a special interest in the conservation of the living resources of the high seas in that area, may request the States whose nationals are engaged in fishing there to adopt the necessary conservation measures, indicating the scientific reasons which make the measures necessary and its special interest.[20] It may then invoke the same procedures looking to agreement or, failing agreement, to settlement of the dispute, as the coastal State.[21] But unlike the coastal State, it is not entitled to adopt unilateral conservation measures or even "to take part on an equal footing in any system of research and regulation" for conservation purposes.[22]

3. Dispute Settlement Machinery

Unless agreement is reached on some other method of peaceful settlement, disputes are to be settled by a five-member special commission named by the parties to the dispute.[23] If they cannot agree on the special commission's membership, any State party to the dispute may request that the Secretary General of the United Nations name the members.[24]

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[11] *Id.*, Art. 6 (1). The concept of the coastal State's "special interest" in conservation may be traced to the Truman Proclamation of 1945. Presidential Proclamation 2668, Sept. 28, 1945, 10 Fed. Reg. 123040 (1945). Neither the Convention nor the Proclamation defines what areas are "adjacent" to the territorial sea or "contiguous" to the coasts of the United States, as the case may be.

[12] *Id.*, Art. 6 (2).

[13] *Id.*, Art. 6 (3).

[14] *Id.*, Art. 7 (1).

[15] *Id.*, Art. 7 (2).

[16] *Id.*, Art. 6 (4).

[17] *Id.*, Art. 7 (4).

[18] *Id.*, Art. 7 (4) and 10 (2).

[19] *Id.*, Art. 6 (5).

[20] *Id.*, Art. 8 (1).

[21] *Id.*, Art. 8 (1) and 8 (2).

[22] *Id.*, Art. 6 (2).

[23] *Id.*, Art. 9 (1) and 9 (2).

Criteria are set forth to guide the special Commission in reaching its decisions. If the dispute concerns the validity of the conservation measures adopted unilaterally by a coastal State, the special Commission shall apply the same criteria that guide the coastal State initially.[25] If the dispute concerns a request by a non-coastal, non-fishing State that conservation measures be adopted, the special commission shall determine whether "scientific findings demonstrate the necessity for conservation measures, or that the conservation program is adequate, as the case may be."[26]

In all other cases, the special Commission shall determine whether (1) scientific findings demonstrate the necessity of conservation measures; (2) the specific measures are based on scientific findings, and are practicable; and (3) the measures do not discriminate, in form or in fact, against fishermen of other States.[27]

A lesser burden is imposed upon the Commission in the case of a dispute initiated by a non-coastal, non-fishing State because of the more limited interest of that State.

The special Commission is authorized to suspend the effectiveness of the conservation measures in dispute pending its decision but, in the case of unilateral conservation measures taken by a coastal State, only if it decides "on the basis of *prima facie* evidence that the need for the urgent application of such measures does not exist."[28]

4. Enforcement

Decisions of the special Commission upholding or rejecting the necessity for conservation or the specific measures adopted are binding on the States concerned; they are also obligated to give the greatest possible consideration to any recommendations that may accompany the Commission's decisions.[29]

5. Activities

Even though 10 years have elapsed since its initial adoption, the Convention has not been ratified by all the important fishing States. The combined catches, in 1965, of the countries which ratified the Convention accounted for about 14 percent of the world's total catch. The United States, United Kingdom, and South Africa–the only major fishing countries in the ratifying group–accounted for more than two-thirds of this 14 percent; the next four, for about one-fifth; and the remaining 17, for about one-eighth.[30] Japan, the Soviet Union and Peru did not sign the Convention.

Nevertheless, the Convention's recognition of the coastal State's "special interest" in conservation may have promoted the development of conservation measures and facilitated some of the recent bilateral agreements between the United States and other countries which are outlined later in this Appendix. Even so, it is very doubtful whether the Convention has become part of international law.

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[24] *Id.*, Art. 9 (2). The Secretary General is required to consult the States in dispute, the President of the International Court of Justice and the Director-General of the U.N. Food and Agriculture Organization. The members must not be nationals of the States involved in the dispute and they must be specialists "in legal, administrative or scientific questions relating to fisheries, depending upon the nature of the dispute to be settled." *Ibid.*

[25] *Id.*, Art. 10 (1).

[26] *Ibid.*

[27] *Ibid.*

[28] *Id.*, Art. 10 (2).

[29] *Id.*, Art. 11.

[30] Herrington, William C., The Future of the Geneva Convention on Fishing and the Conservation of the Living Resources of the Sea, in The Future of the Sea's Resources, Proceedings of the Second Annual Conference of the Law of the Sea Institute 62 (Alexander ed., 1968).

B. International Convention for the Northwest Atlantic Fisheries[31]

1. Objectives

The purpose of the Convention (ICNAF) is to investigate, protect and conserve the stocks of the species of fish which support international fisheries in the Northwest Atlantic Ocean "in order to make possible the maintenance of a maximum sustained catch from those fisheries."[32]

The members of ICNAF are Canada, Denmark, France, Federal Republic of Germany, Iceland, Italy, Norway, Poland, Portugal, Rumania, Spain, Soviet Union, United Kingdom, and the United States.

2. Administrative Organization and Powers

The Convention requires the States Parties to establish and maintain an International Commission for the Northwest Atlantic Fisheries.[33] Each State Party appoints not more than three Commissioners and one or more experts or advisers to assist its Commissioners.[34] The Commission elects a Chairman and Vice Chairman from its members and appoints an Executive Secretary who, in turn, appoints the staff.[35] Each State Party has one vote and the Commission's decisions are taken by a two-thirds majority of the votes of all the State Parties.[36]

The geographical area encompassed by the Convention is divided into five sub-areas and a panel of the States Parties is established and maintained for each of the sub-areas with authority to make recommendations to the Commission and the duty to investigate and report to the Commission upon any matter referred to it.[37]

The Commission is empowered to determine representation on each panel on the basis of "current substantial exploitation in the sub-area concerned of fishes of the cod groups . . . , of flat-fishes . . . , and of rosefish," but the State Party "with coastlines adjacent to a sub-area shall have the right of representation on the panel for the sub-area."[38] The panel reaches its decisions like the Commission.[39]

In the field of scientific investigation, the Commission is responsible for "obtaining and collating the information necessary for maintaining those stocks of fish which support international fisheries in the Convention area."[40] To this end, it may:

a. make such investigations as it finds necessary into the abundance, life history and ecology of any species of aquatic life in any part of the Northwest Atlantic Ocean;

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[31] The Convention was signed at Washington, D.C., February 8, 1949, ratified September 1, 1949 and entered into force for the United States, July 3, 1950, 1 U.S.T. 477; T.I.A.S. No. 2089; 157 U.N.T.S. 157. The Convention has been supplemented by a Declaration of Understanding and several protocols which may be found in a handbook issued periodically by the Commission.

[32] Convention, Preamble.

[33] *Id.*, Art. II (1).

[34] *Id.*, Art. II (2).

[35] *Id.*, Art. II (3), Art. III.

[36] *Id.*, Art. II (7).

[37] *Id.*, Art. I (3), Art. IV, Art. VII. Panel 1 is concerned with the fisheries in sub-area 1, off west Greenland; Panel 2 with the fisheries in sub-area 2, off Labrador; Panel 3 with sub-area 3, off the south and east of Newfoundland and on the Grand Bank; Panel 4 with sub-area 4, in the Gulf of St. Lawrence and on the Nova Scotia Banks; Panel 5, in the Gulf of Maine and on Georges Bank.

The commission has a sixth panel, Panel A, which is concerned with the harp and hood seal fisheries in the convention area. A Protocol to the Convention to bring the harp and hood seals of the northwest Atlantic area under the provisions of the Convention has become effective. The Protocol was signed at Washington, July 15, 1963. 1 U.S.T. 477, T.I.A.S. No. 2089.

Although the United States does not participate in the exploitation of the seals, it will have a right to representation on Panel A because its coastline is adjacent to the Convention area.

[38] *Id.*, Art. IV (2).

[39] *Id.*, Art. IV (4).

[40] *Id.*, Art. VI (1).

b. collect and analyze statistical information relating to the current conditions and trends of the fishery resources of the Northwest Atlantic Ocean;

c. study and appraise information concerning the methods for maintaining and increasing stocks of fish in the Northwest Atlantic Ocean;

d. hold or arrange such hearings as may be useful or essential in connection with the development of complete factual information necessary to carry out the provisions of the Convention;

e. conduct fishing operations in the Convention area at any time for purposes of scientific investigation;

f. publicize and otherwise disseminate reports of its findings and statistical, scientific and other information relating to the fisheries of the Northwest Atlantic Ocean as well as such other reports as fall within the scope of this Convention.[41]

On the recommendations of a panel, or on the basis of scientific investigations, the Commission may transmit to the States Parties proposals for joint action by them to further the objectives of the Convention, but limited to one or more of the following measures:

a. establishing open and closed seasons;

b. closing to fishing such portions of a sub-area as the panel concerned finds to be a spawning area or to be populated by small or immature fish;

c. establishing size limits for any species;

d. prescribing the fishing gear and appliances, the use of which is prohibited;

e. prescribing an overall catch limit for any species of fish.[42]

While the Commission's proposals will ordinarily relate to panel recommendations for particular sub-areas which the Commission may accept with or without modifications,[43] the Commission is also authorized, after consultation with all the panels, to transmit proposals "affecting the Convention area as a whole."[44]

All proposals are transmitted to the States Parties via the "Depository Government"–the United States, which "may make such suggestions as will facilitate acceptance of the proposal."[45] But no proposal becomes effective unless it is accepted by all the States Parties "participating in the panel or panels for the sub-area or sub-areas to which the proposal applies."[46] Furthermore, any State which accepts a proposal may terminate its acceptance at the end of one year from the date on which it became effective. The termination becomes effective at the end of one year from the date of receipt of notice of termination by the Depository Government. Any other State Party may then terminate its acceptance and its termination becomes effective on the date it notifies the Depository Government.[47]

3. Budget

Each State Party undertakes to pay the expenses of the Commissioners, experts, and advisers appointed by it.[48] It also pays a share of the Commission's administrative expenses which varies according to the number of panels on which it is represented.[49] The Commission also has an annual special projects budget which is allocated to the States Parties according to a scale determined by agreement among them.[50]

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[41] *Ibid.*

[42] *Id.*, Art. VIII (1).

[43] *Id.*, Art. VIII (2)-(4).

[44] *Id.*, Art. VIII (5).

[45] *Id.*, Art. XV (1), Art. VIII.

[46] *Id.*, Art. VIII (8).

[47] *Id.*, Art. VIII (8).

[48] *Id.*, Art. XI (1).

In fiscal year 1969, the United States will contribute $7,000 to ICNAF, which is 7 percent of its total estimated expenditures of $100,000. This amount does not include the expenses of the United States Commissioners which are not segregated by Convention. For fiscal year 1969, the expenses incurred by all United States Commissioners serving on all fishing Conventions to which the United States is a Party are expected to total $8,000.

In addition, the United States spent approximately $850,000 on research (in United States research institutions) for ICNAF purposes.[51]

4. Enforcement

The states parties agree "to take such action as may be necessary to make effective the provisions of this Convention and to implement any proposals" which all the interested States have accepted.[52] No other enforcement machinery is provided.

5. Activities[53]

The Commission collects, analyzes, and publishes data on the fish, fish landings and fishing activity. It organizes scientific symposia and encourages cooperative fisheries research.

The principal conservation measure adopted to date is the regulation of mesh size to allow fish to escape in the sizes and quantities recommended by Commission scientists. By 1967, mesh size regulations were enforced for cod and haddock in sub-areas 3 (4-inch), 4 and 5 (4½-inch), and proposed for all groundfish species in sub-areas 1 (5-inch), 2 and 3 (4½-inch), excluding redfish in a certain part of the area, and for cod, haddock and flounders in sub-area 4 (4½-inch).

More detailed information on ICNAF's work and problems are presented in the text of our Report.

C. International Convention on the High Seas Fisheries of the North Pacific Ocean[54]

1. Objectives

The purpose of this Convention (INPFC) is to encourage the conservation of the fishery resources of the North Pacific Ocean, including the adjacent seas, in order to ensure their "sustained productivity."[55] The States Parties to the Convention are Canada, Japan, and the United States.

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[49] *Id.*, Art. XI (3). The following formula is specified:

(a) from the administrative budget there shall be deducted a sum of 500 United States dollars for each contracting Government;

(b) the remainder shall be divided into such number of equal shares as corresponds to the total number of panel memberships;

(c) the payment due from any contracting government shall be the equivalent of 500 United States dollars plus the number of shares equal to the number of panels in which that government participates.

[50] *Id.*, Art. XI (2) and (5).

[51] Information supplied by National Council on Marine Resources and Engineering Development.

[52] Convention, Art. XII.

[53] The following summary of ICNAF's activities is based upon Report of United Nations Secretary General, Marine Science and Technology: Survey and Proposals, E/4487, Annex XII, 24 April, 1968, at 14, which, in turn, seems to be based largely on Statement on ICNAF by U.S. Senate Commerce Committee Staff, Treaties and other International Agreements, etc., 89th Cong., 1st Sess. 61-63 (1965).

[54] This Convention was signed at Tokyo, May 9, 1952; it entered into force for the United States, June 12, 1953. 4 U.S.T. 380, T.I.A.S. No. 2786, 205 U.N.T.S. 65.

[55] Convention, Preamble, Art. I.

2. Administrative Organization and Powers

The Convention requires the States Parties to establish and maintain an International North Pacific Fisheries Commission.[56] Each State Party appoints not more than four members to its "national section" of the Commission.[57] All Commission decisions require the unanimous vote of the three national sections (each section has one vote), except when only two participate in a particular fishery.[58]

The three national sections rotate the offices of the Commission–Chairman, Vice Chairman, and Secretary.[59]

The Commission is entrusted with the following functions:

a. Study, on request of any State Party, any stock of fish which is under substantial exploitation by two or more of the Parties, and which is not covered by a conservation agreement between the Parties existing at the time of the conclusion of the Convention, for the purpose of determining the need for joint conservation measures.

b. Decide and recommend necessary joint conservation measures, including any relaxation thereof to be taken as a result of the study, provided that *only the national sections of the States Parties engaged in substantial exploitation of the stock of fish may participate in the decision and recommendation. The decisions and recommendations shall be reported regularly to all the States Parties but shall apply only to the parties the national sections of which participated in the decisions and recommendations.*

c. Compile and study the records (excluding the records of individual operations) which, upon the Commission's request, the States Parties agree to keep and furnish to the Commission.

d. Submit annually to each State Party a report on the Commission's operations, investigations, and findings, with appropriate recommendations, and inform each State Party, whenever it deems it advisable, on any matter relating to the objectives of the Convention.[60]

In an Annex to the Convention, made an integral part thereof, the stocks of fish subject to the "abstention doctrine" are set forth. In the original Annex, Japan agreed to abstain from fishing, and Canada and the United States agreed to continue to carry out necessary conservation measures, with respect to (1) halibut originating along the coast of North America and found in the Convention area off the coasts of Canada and the United States; (2) herring found in the Convention area off the coasts of Canada and the United States, exclusive of the Bering Sea and of the waters of the North Pacific Ocean west of the meridian passing through the extremity of the Alaskan Peninsula; and (3) salmon originating in the rivers of Canada and the United States and found in the Convention area off the coasts of Canada and the United States, exclusive of the Bering Sea and of the waters of the North Pacific Ocean west of a provisional line following the meridian passing through the western extremity of Atka Island.[61]

Canada and Japan agreed to abstain from fishing, and the United States agreed to continue to carry out necessary conservation measures with respect to salmon originating in the rivers of the United States and found in the Convention area of the Bering Sea east of approximately the line of meridian 175° west longitude and the line following the meridian passing through the western extremity of Atka Island.[62]

The Commission is given the following additional duties with respect to any stock of fish subject to this "abstention doctrine:"

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[56] *Id.*, Art. II (1).

[57] *Id.*, Art. II (2).

[58] *Id.*, Art. II (3).

[59] *Id.*, Art. II (6).

[60] *Id.*, Art. III, VIII.

[61] *Id.*, Art. V (2), Annex.

[62] *Ibid.*

a. Study for the purpose of determining annually whether such stock continues to qualify for abstention. If the Commission determines that the stock no longer meets the conditions for abstention, the Commission shall recommend that it be removed from the Annex.

b. Study, on request of a State Party, any stock of fish of the Convention area, the greater part of which is harvested by one or more of the States Parties, for the purpose of determining whether the stock qualifies for abstention. If the Commission decides that the stock qualifies, it shall recommend (1) that the stock be added to the Annex, (2) that the appropriate Party or Parties abstain from fishing the stocks, and (3) that the Party or Parties participating in the fishing of the stock continue to carry out necessary conservation measures.[63]

In making its recommendations, the Commission is to be guided by the spirit and intent of the Convention and by the following considerations:

a. Any conservation measures for any stock of fish decided upon shall be recommended for equal application to all States Parties engaged in substantial exploitation of the stock.

b. With regard to any stock of fish which the Commission determines reasonably satisfies all the following conditions, a recommendation shall be made for abstention.

(1) Evidence based upon scientific research indicates that more intensive exploitation of the stock will not provide a substantial increase in yield which can be sustained year after year;

(2) The exploitation of the stock is limited or otherwise regulated through legal measures by each Party which is substantially engaged in its exploitation, for the purpose of maintaining or increasing its maximum sustained productivity, such limitations and regulations being in accordance with conservation programs based on scientific research; and

(3) The stock is the subject of extensive scientific study designed to discover whether the stock is being fully utilized and the conditions necessary for maintaining its maximum sustained productivity.[64]

However, the Commission shall make no recommendation for abstention by a State Party concerned with regard to (1) any stock of fish which at any time during the 25 years next preceding the entry into force of the Convention has been under substantial exploitation by that Party; (2) any stock of fish which is harvested in greater part by a country or countries not party to the Convention; (3) waters in which there is historic intermingling of fishing operations of the Parties concerned, intermingling of the stocks of fish exploited by these operations, and a long-established history of joint conservation and regulation among the Parties concerned so that there is consequent impracticability of segregating the operations and administering control.[65] The Convention recognized that the conditions specified in (3) above apply to Canada and the United States in the waters off the Pacific Coasts of these two countries from and including the waters of the Gulf of Alaska southward and, therefore, provided that no recommendation shall be made for abstention by either the United States or Canada in these waters.[66]

3. Budget

Each State Party undertakes to pay the expenses of its national section and to agree on the manner of sharing the joint expenses of the Commission.[67] Furthermore, in performing its functions, the

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[63] *Id.*, Art. III (1) (a) and (b).

[64] *Id.*, Art. IV (1).

[65] *Ibid.*

[66] *Ibid.*

[67] *Id.*, Art. II (11)-(13).

Commission is required, insofar as feasible, to utilize the technical and scientific services of official agencies of the States Parties and may, when desirable and if available, utilize the services of any public or private institution or organization or any private individual.[68]

In fiscal year 1969, the United States will contribute $24,000 to the work of the Commission, which will amount to a third of its estimated total expenditures of $72,000. In addition, the United States spent $1.5 million on research (in U.S. research institutions) for purposes of INPFC.[69]

4. Enforcement

To enforce the provisions of the Convention, the State Parties agree:

a. With regard to a stock from the exploitation of which a State Party has agreed to abstain, the nationals and fishing vessels of the abstaining State Party are prohibited from engaging in the exploitation of the stock in the waters specified in the Annex, and from loading, processing, possessing or transporting the fish in such waters.

b. With regard to a stock of fish for which a State Party has agreed to continue to carry out conservation measures, the nationals and fishing vessels of such State Party are prohibited from engaging in fishing activities in water specified in the Annex in violation of regulations established under the conservation measures.

c. For the purpose of rendering effective the provisions of the Convention, each Party will enact and enforce necessary laws and regulations with regard to its nationals and fishing vessels, with appropriate penalties against violations thereof, and transmit to the Commission a report on any action taken by it with regard thereto.

d. When a fishing vessel of a State Party has been found in waters in which that Party has agreed to abstain from exploitation, the duly authorized officials of any *State Party may board the vessel to inspect its equipment, books, documents and other articles and question the persons on board.*

e. When any such person or fishing vessel is actually engaged in operations in violation of the provisions of the Convention, or there is reasonable ground to believe that it was obviously so engaged immediately prior to boarding of the vessel by any such official, the latter may arrest or seize such person or vessel. In that case the State Party to which the official belongs shall notify the State Party to which the offending person or vessel belongs of the arrest or seizure, and shall deliver such vessel or person as promptly as practicable to the authorized officials of the State Party to which the offending vessel or person belongs.

f. Only the authorities of the State Party to which the offending person or vessel belongs may try the offense and impose penalities.

g. With regard to the nationals or fishing vessels of one or more States Parties in waters with respect to which they have agreed to continue to carry out conservation measures for certain stocks of fish, the States Parties concerned shall carry out enforcement severally or jointly and shall provide a report periodically, through the Commission, to the abstaining Party on enforcement conditions and, if requested, give it an opportunity for observation of the conduct of enforcement.[70]

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[68] *Id.*, Art. III (3).

[69] Information was supplied by the National Council on Marine Resources and Engineering Development.

[70] Convention, Arts. IX, X.

The Commission is also given the following enforcement functions:

(1) To make recommendations to the States Parties regarding the enactment of schedules of equivalent penalties for violations of the Convention.[71]

(2) To take such steps in agreement with the Parties concerned, as will enable it to determine the extent to which the undertakings agreed to by the Parties in connection with the abstention provisions, and with any other measures recommended by the Commission and accepted by the Parties concerned, have been effective.[72]

(3) To request the States Parties concerned to report regularly the conservation measures adopted from time to time with regard to the stocks of fish subject to abstention whether or not covered by conservation agreements between the Parties and to transmit the information to the other Parties.[73]

Finally, if it comes to the attention of any of the States Parties that the nationals or fishing vessels of any State which is not a Party to the Convention appear to affect adversely the operations of the Commission or the objectives of the Convention, such Party shall call the matter to the attention of the other Parties. All the Parties agree, upon the request of such Party, to confer upon the steps to be taken towards obviating such adverse affects or relieving any Party from them.[74]

5. Activities

The Commission has served "as a forum for the discussion of fishery problems of mutual concern, as a liaison center for the exchange of technical and scientific information, and a panel of experts for the review and coordination of national programs of research on high seas fishery resources."[75] It has been responsible for the design of perhaps the largest single fishery research program undertaken to date. As a result of the research activities of the three States Parties, carried out under the Commission's aegis, the knowledge of salmon has been increased immeasurably.

The original line (roughly 175° west longitude) agreed upon to separate North American salmon stock from Asian salmon stock was declared to be "provisional" in a Protocol to the Convention. The United States maintains that subsequent biological studies reveal that North American salmon, particularly the red salmon from Bristol Bay, range further to the west than the "provisional line" and that substantial numbers migrate out as far as 175° east longitude and thereby are subjected to unwarranted harvest by the Japanese fishing fleet.[76] Although the United States requested that the "provisional line" be moved far enough west of its present location to assure the protection of salmon spawned in North American lakes and streams, the line has not been moved.

In 1962, the Commission decided that the herring stocks off the west coast of the Queen Charlotte Islands and the halibut stock of the eastern Bering Sea no longer qualified for abstention. Its recommendation that these stocks be removed from the Annex was accepted by the States Parties. With respect to halibut and herring, therefore, the abstention doctrine presently applies to (a) halibut originating along the coast of North America and found in the Convention area off the coast of Canada and the United States, exclusive of the Bering Sea; and (b) herring of Canadian origin found in the Convention area off the coast of Canada, exclusive of the waters of the high seas north of 51° 56′ north latitude, west of the Queen Charlotte Islands and west of a line drawn between Langara Point or Langara Island, Queen Charlotte Islands, and Cape Muyon or Dall Island in Southeast Alaska.[77]

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[71] *Id.*, Art. III (1) (d).

[72] *Id.*, Art. III (2).

[73] *Id.*, Art. III (1) (c) (iii).

[74] *Id.*, Art. VI.

[75] Statement by United States Senate Commerce Committee Staff on INPFC, Treaties and other International Agreements etc., *supra* note 53, at 90.

[76] *Id.* at 91. "During the last nine years it is believed that the Japanese have taken more than 27 million salmon of Bristol Bay origin." *Ibid.*

In November 1962, the Japanese government informed the Canadian and United States governments of its desire to negotiate a revision of the Convention. The first meeting was held in June 1963, at which the Japanese delegation proposed to eliminate the abstention doctrine and provide for joint conservation measures. It called attention to the intrusion of large Soviet fishing fleets into the Convention area. It also pointed out that the Japanese bottom fish fleet operating off Alaska could not avoid catching a substantial number of halibut in their nets which, under the treaty, had to be thrown back into the sea. Because it was difficult to sort out and throw back the halibut, many of which were necessarily injured in the process, and because the value of the Japanese bottom fishery was disproportionately greater than that of the United States halibut fishery, the Japanese urged a change in the treaty to allow them to retain these accidentally caught fish. The United States and Canada rejected the Japanese proposals.

At a meeting held in Tokyo in September 1963, to further consider amendment of the Convention, the United States agreed to drop the abstention principle as such but still proposed to require the Japanese to refrain from fishing the stocks of fish subject to that principle. In return, the United States proposed that all parties to the new treaty restrict their fishing east of the 175 degree line to waters and methods used in the previous five years. This would prohibit Japan from all salmon fishing east of the line and would prevent any expansion of Japanese halibut fishing in the same area. It would also prohibit Canada and the United States from changing catching methods or exploiting bottom fish which Japan had been taking east of the 175 degree line. The apparent intent of the new provision was to create the appearance of bilateral restraint, that is, restraint in fishing effort by both the United States and Japan, and not merely by Japan. Japan did not accept these proposals. It claimed that they totally ignored the three basic principles which Japan demanded: freedom of the high seas, equal access to the resources, and joint control measures for the conservation of the fisheries. The Tokyo discussions produced no results, and a third round of talks to amend the Convention, held in Ottawa in September 1964, ended without agreement. No date or place was set for any further meeting.

To increase the pressure on the Japanese, the United States Senate passed a bill on May 19, 1965, permitting the President to increase import duties on fish products by as much as fifty per cent for any countries whose practices were "found to be injurious to United States Fish Conservation Programs."[78] Although Japan was not specifically mentioned, the sponsors of the bill made it clear that Japan was the country to be punished.[79] Moreover, during May, the newly formed Congress of American Fishermen threatened a national boycott of Japanese imports, effective June 1, 1965, unless the Japanese agreed not to fish for United States spawned salmon, east or west of the abstention line. At about the same time, the Governor of Alaska proposed a plan to build a low dam across Bristol Bay which would stop the migration of the salmon into the sea.[80]

However, public criticism of Japanese activity decreased very rapidly as the 1965 season progressed, when it became apparent that a record run was under way. Whether or not the allegations that the Japanese fishermen were depleting the Bristol Bay stocks were true, the criticism became subdued in the face of the largest run in history. The heated accusations of 1965 were not repeated in 1966, or at least they appeared in a much milder form, both sides apparently being resigned to a continuation of the status quo.

As of early 1968, no new negotiations had been held, and none were planned, but both sides continued to express their dissatisfaction with the present arrangements.

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[77] Amendments to the Annex to the Convention, adopted at Seattle, Nov. 17, 1962; entered into force for the United States, May 8, 1963, T.I.A.S. No. 5385, 14 U.S.T. 953.

[78] S. 1734, 89th Cong., 1st Sess. (1965).

[79] S. Rep. No. 194, 89th Cong., 1st Sess. 4-7 (1965).

[80] Johnson, The Japan-United States Salmon Conflict, 43 Wash. L. Rev. 11-12 (1967). The account in the text is based almost entirely on this source.

D. Interim Convention on Conservation of North Pacific Fur Seals[81]

1. Objectives

The purpose of the Convention is to achieve:

the maximum sustainable productivity of the fur seal resources of the North Pacific Ocean so that the fur seal population can be brought to and maintained at the levels which will provide the greatest harvest year after year, with due regard to their relation to the productivity of other living marine resources of the area.[82]

The States Parties to the Convention are Canada, Japan, the Soviet Union and the United States.

2. Administrative Organization and Powers

The Convention requires the State Parties to establish the North Pacific Fur Seal Commission, to be composed of one member from each Party.[83] The decisions and recommendations of the Commission must be made by unanimous vote, with each Party having one vote.[84] However, with respect to any recommendations regarding the size and the sex and age composition of the seasonal commercial kill from a herd, only those Parties sharing in the sealskins from that herd are entitled to vote.[85] The Commission elects its chairman from its members.[86]

To attain the Convention's objectives, each State Party agrees to prohibit any person or vessel subject to its jurisdiction from engaging in pelagic sealing, i.e., the killing, taking or hunting in any manner whatsoever of fur seals at sea, except in specified numbers for research purposes, in the Pacific Ocean north of the 30th parallel of north latitude, including the Seas of Bering, Okhotsk and Japan.[87] It also agrees to cooperate in investigating the fur seal resources of the North Pacific Ocean and, particularly, in studying:

(a) the size of each fur seal herd and its average age and sex compostion;

(b) the natural mortality of the different age groups and recruitment of young to each age or size class at present and subsequent population levels;

(c) with regard to each of the herds, the effect upon the magnitude of recruitment of variations in the size and the age and sex compositon of the annual kill;

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[81] This Convention was signed at Washington, Feb. 9, 1957 and entered into force for the United States, Oct. 14, 1957, 8 U.S.T. 2283, T.I.A.S. No. 3948, 314 U.N.T.S. 105.

The original Convention was to continue in force for six years, but the Parties agreed to meet early in the sixth year to decide whether it should be continued in force. Convention, Art. XIII (4), Art. XI. This was done and a Protocol eventuated amending the Convention but continuing it for another six years. The Protocol was signed at Washington, Oct. 9, 1963, entered into force for the United States, April 10, 1964. T.I.A.S. No. 5558. The account of the Convention set forth below is based upon its amended provisions.

[82] Convention, Preamble. The final clause was added to take account of the possibility that fur seals prey upon salmon, a fish highly valued by all four States Parties.

[83] *Id.*, Art. V (1).

[84] *Id.*, Art. V (4).

[85] *Ibid.*

[86] *Id.*, Art. V (5).

[87] *Id.*, Art. III, Art. I (1). The prohibition against pelagic sealing does not apply to Indians, Ainos, Aleuts, or Eskimos dwelling on the coast of the waters in question who carry on pelagic sealing in canoes not transported by or used in connection with other vessels, and propelled entirely by oars, paddles, or sails, and manned by not more than five persons each, in the way hitherto practiced and without the use of firearms; provided that such hunters are not in the employment of other persons or under contract to deliver the skins to any person. *Id.*, Art. VII.

(d) migration routes of fur seals and their wintering areas;

(e) numbers of seals from each herd found on the migration routes and in wintering areas and their ages and sexes;

(f) extent to which the food habits of fur seals affect commercial fish catches and the damage fur seals inflict on fishing gear;

(g) effectiveness of each method of sealing from the viewpoint of management and rational utilization of fur seal resources for conservation purposes;

(h) quality of sealskins by sex, age and time and method of sealing; and

(i) other subjects which the Commission determines will help achieve the Convention's objectives.[88]

Each Party agrees to continue to mark an adequate number of pups; to devote to pelagic research an effort similar in extent to that expended in recent years, provided that not more than 2,500 seals are taken in the Eastern and not more than 2,200 seals in the Western Pacific Ocean, unless the commission decides otherwise; and to carry out the Commission's determinations.[89]

Only government-owned or government-chartered vessels operating under strict control of their respective authorities may be used in pelagic research.[90]

Each Party also agrees to provide the Commission annually with information on the number of black pups tagged for each breeding area; the number of fur seals, by sex and estimated age, taken at sea and in each breeding area; and tagged seals recovered on land and at sea.[91]

The Commission is given the following duties in connection with these programs of research:

(a) formulate and coordinate research programs designed to achieve the objectives of the Convention;

(b) recommend coordinated research programs to the Parties for implementation;

(c) study the data obtained from the coordinated research programs;

(d) recommend appropriate measures to the Parties on the basis of the findings obtained from the coordinated research programs, including measures regarding the size and sex and age of the seasonal commercial kill from a herd;

(e) study whether or not pelagic sealing in conjunction with land sealing could be permitted in certain circumstances without adversely affecting achievement of the objectives of the Convention, and make recommendations in this regard to the Parties when they must once again determine whether the Convention should be continued;

(f) determine from time to time the number of seals to be marked on the rookery islands, and the total number of seals which shall be taken at sea for research purposes, the times at which they shall be taken, and the areas in which they shall be taken, as well as the number to be taken by each party.[92]

The prohibition of pelagic sealing, in effect, meant that Canada and Japan agreed to engage in no sealing; the United States agreed to manage the seal herds on the Pribilof Islands and the Soviet Union the seal herds on the Commander Islands and Robben Island. In return, the Soviet Union and the United States agreed to deliver to Canada and Japan each 15 percent of the "gross in number and value" of the sealskins taken commercially each season on these respective breeding grounds.[93]

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[88] *Id.*, Art. II (2).

[89] *Id.*, Art. II (3).

[90] *Id.*, Art. II (6).

[91] *Id.*, Art. II (4).

[92] *Id.*, Art. V (2) and (3).

However, it is further provided that if the number of seals of either the Commander Islands or the Robben Island breeding grounds falls below 50,000 head, according to data in official records, then the commercial killing of seals and apportionment of skins may be suspended by the Soviet Union until the number of seals exceeds 50,000 in the breeding grounds in question.[94] The Commission is authorized to modify the 50,000 figure in accordance with its scientific findings.[95]

If the Soviet Union suspends sealing on the Commander Islands or Robben Island, the Commission must determine whether or not to reduce the level or to suspend completely the pelagic sealing for scientific purposes in the Western Pacific Ocean during the period of suspension.[96]

3. Budget

Each State Party undertakes to bear the expense of its own research, but it retains title to sealskins taken during the research.[97] Each Party also pays the expenses of its Commissioner and or equal share of the joint expenses incurred by the Commission.[98] It must also contribute to the Commission annually an amount equal to the value of the sealskins it confiscates in accordance with the Convention's enforcement provisions.[99]

Finally, special provision is made to divide the costs of pelagic research in the Western Pacific Ocean more equitably. Canada and Japan agree to forego the delivery of the sealskins otherwise due them from the Soviet Union for a three-year period, the Soviet Union agrees to deliver annually to Canada and Japan 1,500 sealskins each during these three years.[100]

In fiscal year 1969, the United States will contribute $2,000 to the Commission's expenses, which will amount to 25 percent of its estimated total expenditures of $8,000. In addition, the United States will spend in fiscal 1969 approximately $200,000 on research (in United States research institutions) for purposes of this Convention.[101]

4. Enforcement

To enforce the provisions of the Convention, each State Party agrees:

(a) To enact and enforce the legislation necessary to guarantee compliance with the Convention's provisions, with appropriate penalties for violation thereof;

(b) To cooperate with each other in taking appropriate measures to carry out the purposes of the Convention, including the prohibition of pelagic sealing.[102]

(c) When a duly authorized official of any of the Parties has reasonable cause to believe that any vessel subject to the jurisdiction of any of the Parties is offending against the prohibition of pelagic sealing, he

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[93] *Id.*, Art. IX (1) and (2).

[94] *Id.*, Art. IV (2).

[95] *Id.*, Art. IV (4).

[96] *Id.*, Art. IV (3).

[97] *Id.*, Art. IV (1).

[98] *Id.*, Art. V (7).

[99] *Ibid.*

[100] *Id.*, Art. IX (3).

[101] The data in the text were supplied by National Council on Marine Resources and Engineering Development, the Department of State and the Department of the Interior.

[102] Convention, Art. X.

may, except within the territorial waters of another state, board and search the vessel. The official is to carry a special certificate issued by his government, which shall be exhibitied to the master of the vessel upon request. After having searched the vessel, if the officer continues to have reasonable cause to believe that the vessel or any person on board is offending against the prohibition, he may seize or arrest the vessel or person. In that case, the Party to which the official belongs shall as soon as possible notify the Party having jurisdiction over the offending vessel or person of the arrest or seizure and shall deliver the vessel or person as promptly as practicable to the authorized officials of the Party having jurisdiction over the offending vessel or person at a place to be agreed upon by both Parties.

The State Party to which the offending person or vessel belongs alone shall have jurisdiction to try any case of alleged violation and to impose penalties. Sealskins discovered on seized vessels shall be subject to confiscation on the decision of the court or other authorities of the Party under whose jurisdiction the trial of the case takes place. Full details of punitive measures applied to the offenders shall be communicated to the other Parties not later than three months after the application of the penalty.[103]

(d) No person or vessel shall be permitted to use any of its ports or harbors or any part of its territory, for any purpose designed to violate the prohibitions of the Convention.

(e) To prohibit the importation and delivery into and the traffic within its territory of skins of fur seals taken in the area of the North Pacific in which taking is prohibited, except only those taken by the Soviet Union or the United States on rookeries, those taken at sea for research purposes, those confiscated for violation of the Convention and those inadvertently captured which are taken possession of by a Party.[104]

(f) If any Party considers that the obligations of the Convention are not being carried out and notifies the other Parties to that effect, all the Parties shall, within three months of receipt of the notification, meet to consult on the need for and nature of remedial measures. If agreement on such measures is not forthcoming, any Party may give written notice of its intention to terminate the Convention and the Convention shall then terminate sooner than is otherwise provided.[105]

5. Activities

The Convention is the successor of the first international treaty designed to prevent the extinction of a marine animal. Entered into in 1911, it produced favorable results. By 1916, the Pribilof herd nearly doubled in size. By 1930, the herd increased to about 1.5 million individuals. In October 1940, Japan gave notice of its intention to terminate its participation in the treaty within a year, which it did. It was not until 1957 that the four Parties to the 1911 Convention concluded a new treaty. In the interim, agreements between Canada and the United States tried to prevent the situation from deteriorating too seriously.

The creation of the Commission was the principal innovation of the new treaty.

As a result of the treaty, Ambassador McKernan writes:

> *. . . the Pacific fur seal herds have increased from approximately 110,000 to about 1,500,000 animals . . . At the present time, the Pribilof fur seal herd is producing at the maximum sustainable yield level and there is every reason to conclude that this conservation has been successful and very much in the interest of the United States.*[106]

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[103] *Id.*, Art. VI.

[104] *Id.*, Art. VIII.

[105] *Id.*, Art. XII.

[106] McKernan, Donald, International Fishery Policy and the United States Fishing Industry, paper presented to Conference on the Future of the United States Fishing Industry, Seattle, Washington, March 24-27, 1968, at p. 2.

The provisions of the Convention dividing the annual yield of fur seals–the first of their kind in the world–have worked remarkably well for almost 60 years. A number of special factors may have contributed to this success. No private businessmen are involved in fur seal catching; and there is no problem of new entrants because the entire fur seal business is of relatively small economic interest and the cost of entry to nations outside the North Pacific is relatively high.[107]

E. Convention for the Establishment of an Inter-American Tropical Tuna Commission[108]

1. Objective

The purpose of this Convention is to "facilitate maintaining the populations of" yellowfin and skipjack tuna and of other kinds of fish taken by tuna fishing vessels in the eastern Pacific Ocean "at a level which will permit maximum sustained catches year after year."[109]

The States Parties to the Convention originally were Costa Rica and the United States, but the Convention extended an invitation to join to all other States whose nationals participated in the fisheries covered by it.[110] Since it became effective, Ecuador, Panama, Mexico and Canada have become Parties to the Convention, but Ecuador has served notice of withdrawal.

2. Administrative Organization and Powers

The States Parties agree to establish and operate the Inter-American Tropical Tuna Commission, to be composed of national sections, each consisting of from one to four members appointed by each State Party.[111] Decisions, resolutions, recommendations and publications of the Commission must be made by unanimous vote, with each national section having one vote.[112] The Commission elects a Chairman and a Secretary from different national sections, but these offices must rotate so that each State Party will have an opportunity to be represented in these offices.[113] The Commission is authorized to employ necessary personnel for the performance of its functions and duties.[114] It is also authorized to designate a Director of Investigations to serve at its pleasure and to perform the following tasks subject to the Commission's instruction and approval:

a. the drafting of programs of investigations and preparation of budget estimates;

b. authorizing disbursement and accounting of funds for the joint expenses of the Commission;

c. the appointment and immediate direction of technical and other personnel required for the functions of the Commission;

d. arrangements for cooperation with other organizations or individuals;

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[107] Chapman, The Theory and Practice of International Fisheries Commissions and Bodies, presented at the Symposium on International Fisheries Problems, Gulf and Carribbean Fisheries Institute, San Juan, Puerto Rico, Nov. 15, 1967, at 13-14.

[108] This Convention was signed at Washington, May 31, 1949 and entered into force for the United States March 3, 1950, T.I.A.S. No. 2044.

[109] Convention, Preamble. The area in question has been roughly interpreted to include waters from southern California to northern Chile, a distance of 4,500 miles, and as far eastward as tropical tuna found in coastal waters travel.

[110] *Id.*, Art. V (3).

[111] *Id.*, Art. I (1).

[112] *Id.*, Art. I (8).

[113] *Id.*, Art. I (7).

[114] *Id.*, Art. I (10).

e. the coordination of the work of the Commission with that of organizations and individuals whose cooperation has been arranged for;

f. the drafting of administrative, scientific and other reports for the Commission; and

g. the performance of such other duties as the Commission may require.

In the performance of its duties and functions, the Commission may request the technical and scientific services of, and information from, official agencies of the States Parties, and any international, public, or private institution or organization, or any private individual.[115]

The Commission is to perform the following functions and duties:

(1) investigate the abundance, biology, biometry and ecology of yellowfin and skipjack tuna in the waters of the Eastern Pacific Ocean fished by the nationals of the States Parties, and the kinds of fish commonly used as bait in the tuna fisheries, especially the anchovetta, and of other kinds of fish taken by tuna fishing vessels; and the effects of natural factors and human activities on the abundance of the populations of fishes supporting all these fisheries.

(2) collect and analyze information relating to current and past conditions and trends of the populations of the fish covered by the Convention.

(3) study and appraise information concerning methods and procedures for maintaining and increasing the populations of fish covered by the Convention.

(4) conduct such fishing and other activities as may be necessary to attain the Convention's objectives.

(5) recommend from time to time, on the basis of scientific investigations, proposals for joint action by the States Parties designed to keep the populations of fishes covered by the Convention at those levels of abundance which will permit the maximum sustained catch.

(6) collect statistics and all kinds of reports concerning catches and the operations of fishing boats, and other information concerning the fishing for fishes covered by the Convention, from vessels or persons engaged in these fisheries.

(7) publish or otherwise distribute reports regarding the results of its findings and such other reports as fall within the scope of the Convention, as well as scientific, statistical, and other data regarding the fisheries maintained by the nationals of the States Parties for the fishes covered by the Convention.[116]

3. Budget

Each State Party undertakes to bear the expenses incurred by its national section and to share the Commission's joint expenses in such manner as the Commission recommends and they approve, but related to the proportion of the total catch from the fisheries covered by the Convention utilized by each.[117]

In fiscal year 1969, the United States will contribute $416,000 to pay the Commission's joint expenses, which will amount to 96 percent of its estimated total expenditures of approximately $435,000.[118]

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[115] *Id.*, Art. I (13).

[116] *Id.*, Art. II.

[117] *Id.*, Art. I (3), (4).

[118] The data in the text were supplied by National Council on Marine Resources and Engineering Development.

4. Enforcement

The States Parties to the Convention agree to enact such legislation as may be necessary to carry out the purposes of the Convention.[119]

5. Activities

The scientific work of the Commission's staff is generally regarded as competent and productive and has led to an expansion of knowledge of the eastern tropical and sub-tropical Pacific.[120]

Fishing effort of yellowfin tuna in the Eastern Pacific has come close to threatening the maximum sustainable yield and has led the Commission during the past several years to recommend regulation of such effort; skipjack tuna, however, will stand considerably greater yields than presently taken.[121] Yet it is difficult to catch one species without catching the other; the fishery operates generally upon both and the economics of the industries are dependent upon the yield from both.[122]

Beginning in 1962, the Commission recommended conservation measures (an overall catch quota for yellowfin) to the States fishing the two species. Its recommendation was not accepted until 1966. During 1966, 1967, and 1968, however, an overall catch quota was in force and observed by all States fishing for yellowfin, whether Parties or not.[123]

F. International Convention for the Regulation of Whaling[124]

1. Objectives

The Preamble to the Convention states that the Parties recognize that:

a. the nations of the world are interested in safeguarding for future generations the natural resources represented by whale stocks;

b. the history of whaling is one of overfishing of one area after another and of one species after another to such a degree that it is essential to protect all species from overfishing;

c. the whale stocks are susceptible of natural increases if whaling is properly regulated;

d. increases in the size of whale stocks will permit increases in the numbers of whales which may be captured without endangering the resource;

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[119] Convention, Art. III.

[120] See Chapman, *supra* note 107, at 18. "By the end of 1966, the Commission had published and given worldwide distribution to eighty-five scientific bulletins, more than 100 scientific papers and articles in outside journals and fifteen annual reports." Report of the UN Secretary General, Marine Science and Technology: Survey and Proposals, E/ 4487, April 24, 1968, Annex XII, at 20.

[121] Chapman, *supra* note 107, at 18-19.

[122] *Ibid.*

[123] Report of the UN Secretary General, *supra* note 120, at 20; Burke, Aspects of International Decision-Making Processes in Intergovernmental Fishery Commissions, 43 Wash. L. Rev. 115, 151 (1967). See also Treaties and other International Agreements etc., *supra* note 53, at 73-74.

[124] The Convention was signed at Washington, Dec. 2, 1946; it entered into force for the United States, November 10, 1948, T.I.A.S. No. 1849, 161 U.N.T.S. 72. It superseded the Convention for the Regulation of Whaling, signed at Geneva, Sept. 24, 1931, entered into force for the United States Jan. 16, 1935, T.S. 880, IV Trenwith 5372, 155 L.N.T.S. 349; the International Agreement for the Regulation of Whaling signed in London on June 8, 1937, T.S. 933; and the Protocols to that Agreement signed in London on June 24, 1938, T.S. 944 and Nov. 26, 1945, T.I.A.S. No. 1597.

The Convention applied to factory ships, land stations and whale catchers under the jurisdiction of the States Parties operating anywhere in the world. A Protocol signed in Washington Nov. 19, 1956, entered into force for the United States May 4, 1959, 10 U.S.T. 952, T.I.A.S. No. 4228, 338 U.N.T.S. 366, extended the application of the Convention to helicopters and other aircraft used for the purpose of hunting, taking, killing, towing, holding on to, or scouting for whales.

e. it is in the common interest to achieve the optimum level of whale stocks as rapidly as possible without causing widespread economic and nutritional distress;

f. in the course of achieving these objectives, whaling operations shall be confined to those species best able to sustain exploitation in order to give an interval for recovery to certain species of whales now depleted in number;

g. it is desirable to establish a system of international regulation for whale fisheries to ensure proper and effective conservation of whale stocks and thus make possible the orderly development of the whaling industry.[125]

The States Parties to the Convention are Argentina, Australia, Canada, Denmark, France, Iceland, Japan, Mexico, Netherlands, New Zealand, Norway, Panama, South Africa, the Soviet Union, the United Kingdom and the United States.

2. Administrative Organization and Powers

The States Parties agree to establish an International Whaling Commission composed of one member from each Party, who may be accompanied by one or more experts and advisers.[126] Decisions of the Commission are taken by a simple majority of those members voting, with each member having one vote, but a three-fourths majority is required to adopt conservation measures.[127] The Commission elects a Chairman and Vice Chairman from its own members and appoints its own secretary and staff.[128]

The Commission is entrusted with the following functions, which it may discharge in collaboration with or through independent agencies of the States Parties or other public or private agencies, establishments, or organizations, or independently:

a. encourage, recommend, or if necessary, organize studies and investigations relating to whales and whaling;

b. collect and analyze statistical information concerning the current condition and trend of the whale stocks and the effects of whaling activities therein;

c. study, appraise, and distribute information concerning methods of maintaining and increasing the populations of whale stocks;

d. arrange for the publication of reports of its activities and publish independently or in collaboration with the International Bureau for Whaling Statistics at Sandefjord in Norway and other organizations and agencies such reports as it deems appropriate as well as statistical, scientific and other pertinent information relating to whales and whaling; and

e. make recommendations, from time to time, to the State Parties on any matters which relate to whales or whaling and to the objectives and purposes of the Convention.[129]

A Schedule to the Convention, made an integral part thereof, contains the detailed conservation measures to which the parties have agreed. In general, they contain provisions, which the Commission is authorized to amend from time to time, fixing protected and unprotected species; open and closed seasons; open and closed waters, including the designation of sanctuary areas; size limits for each species; time, methods and intensity of whaling (including the maximum catch of whales to be taken in any one season); types and specifications of gear and apparatus and appliances which may be used; methods of measurement; catch returns and other statistical and biological records; and methods of inspection.[130]

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[125] Convention, Preamble.

[126] *Id.*, Art. III (1).

[127] *Id.*, Art. III (1), (2).

[128] *Id.*, Art. III (2), (3).

[129] *Id.*, Art. IV, VI.

The Commission's recommendations for amendment must be based on scientific findings. They must not involve restrictions on the number or nationality of factory ships or land stations, nor allocate specific quotas to any factory ship or land stations or to any group of factory ships or lands stations. They must take into consideration the interests of the consumers of whale products and the whaling industry.[131]

Each of the amendments to the schedule becomes effective 90 days after the Commission notifies each of the Parties thereof, but a procedure is laid down under which any Party may object thereto, in which case it is not bound by the amendment.[132]

The Convention specifically exempts from prohibitions that may otherwise be applicable the killing, taking and treating of whales for purposes of scientific research.[133]

3. Budget

Each State Party undertakes to bear the expenses incurred by its Commissioner and his experts and advisors.[134] Although the Convention contains no provision for the sharing of the joint expenses incurred by the Commission, in fiscal year 1969, the United States will contribute $1,000 to pay these joint expenses, which is 6 per cent of the Commission's estimated total expenditures of approximately $16,700. The Commission employs a part-time secretary, but no scientific staff of its own, though it is authorized to do so. In addition, the United States will spend $65,000 in fiscal 1969 on research (in United States research institutions) for purposes of this Convention.[135]

4. Enforcement

Each party agrees to take appropriate measures to ensure the application of the provisions of the Convention and the punishment of violations by persons or vessels under its jurisdiction.[136] Prosecution for alleged violations of the Convention is to be instituted by the State Party having jurisdiction over the offense.[137] Each Party also undertakes to transmit to the Commission full details of each violation by persons or vessels under its jurisdiction as reported by its inspectors, including a statement of the measures taken for dealing with the violation and the penalties imposed.[138] Each State is prohibited from paying any bonus or other remuneration calculated with relation to the results of their work to the gunners and crews of whale catchers in respect of any whales taken in violation of the provisions of the Convention.[139]

Further to assure compliance the Schedule requires that two inspectors shall be maintained on each factory ship, that land stations be adequately inspected and that detailed accounts be kept of every whale taken. These statistics must be transmitted promptly to the International Bureau of Whaling Statistics at Sandefjord in Norway.[140]

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[130] *Id.*, Art. V (1), as amended by the Protocol.

[131] *Id.*, Art. V (2).

[132] *Id.*, Art. V (3).

[133] *Id.*, Art. VIII.

[134] *Id.*, Art. III (5).

[135] Information supplied by National Council on Marine Resources and Engineering Development.

[136] *Id.*, Art. IX (1).

[137] *Id.*, Art. IX (3).

[138] *Id.*, Art. IX (4).

[139] *Id.*, Art. IX (2).

[140] *Id.*, Art. VII, Schedule.

The Amendment to the Convention effectuated by the Protocol which authorized the Commission to adopt regulations fixing "methods of inspection" was intended to assure that impartial inspectors participated in the observation of whaling activities. It was anticipated that an international corps of neutral observers would be established, responsible to and paid by the Commission; and that one such observer, not a national of the country of registration, would be assigned by the Commission to each factory ship on a seasonal basis.[141] But no such international system of inspection was inaugurated and the agreement to establish it has expired.

5. Activities

Although the research sponsored by the Commission "has added greatly to knowledge of the size and sustainable yield of the existing stocks of whales", the regulatory activity of the Commission has not been successful and the fear has been expressed that "there is the distinct possibility that (the Commission) may soon become defunct, together with the whale resources and the whaling industry."[142] More recent events, described below, afford a basis for a less pessimistic view.

Antarctic whaling has presented the Commission with its most difficult problems. The Antarctic is the principal remaining area where are found commercially exploitable concentrations of baleen whales. The Antarctic overall catch quota was originally set by the Convention at 16,000 blue whale units (one blue whale unit equals one blue whale, or two fin whales, or two and one half humpback whales, or six sei whales).[143] Many regarded this quota as too high, but it was dictated in large part by the serious shortage of edible fats and oils in the European countries immediately after World War II.[144] In response to evidence that the Antarctic stocks were declining at an accelerating rate, the Commission lowered the quota to 15,500 units in 1953, 15,000 in 1955 and 14,500 in 1956. It was increased to 15,000 in 1959. The quota was suspended for 1960 and 1961, restored to 15,000 in 1962 and lowered to 10,000 in 1963.[145] In 1963, also, complete protection for humpback whales and almost complete protection for blue whales was imposed.[146]

That the 10,000 quota was in effect no limitation became evident when the catch of all the whaling countries in the 1963/64 season totalled only 8,429 units.[147] In 1964, the scientists estimated that a quota of less than 3,000 units would be required to make a start on recovery of the fin whales and sei whales and that complete protection of blues and humpbacks would continue to be required.[148] But the Antarctic whaling countries were unable to agree on any quota and so none was fixed by the Commission for the 1964/65 season.[149]

In 1958 and 1959, the nations then engaged in whaling in the Antarctic (Soviet Union, Japan, United Kingdom, Norway, Netherlands) met outside the confines of the Convention in an attempt to allocate the total catch among themselves. The Convention itself prohibits the Commission from making such an allocation.[150] No agreement was reached,[151] but negotiations continued, accompanied by threats by Norway and the Netherlands to withdraw from the Convention.

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[141] This account of the effort at establishing a system of international inspection is based upon Johnston, The International Law of Fisheries 410 (1965).

[142] Statement by United States Senate Commerce Committee Staff, Treaties and other International Agreements etc., *supra* note 53, at 199-200.

[143] Convention, Original Schedule, par. 8.

[144] Statement of United States Senate Commerce Committee Staff, Treaties and other International Agreements etc., *supra* note 53, at 199.

[145] *Id.*, Schedule as amended as of Jan. 22, 1965, par. 8. Twelfth (1961) Annual Report of International Commission on Whaling, at 3.

[146] *Id.*, Schedule as amended Jan. 22, 1965, par. 8.

[147] Statement of United States Senate Commerce Committee Staff, Treaties and other International Agreements etc., *supra* note 53, at 200.

[148] *Ibid.*

[149] *Ibid.*

Finally, in 1962, the five Antarctic whaling States agreed to the following national quotas to be observed until the end of the 1965/66 season: Japan, 33 per cent; Norway, 32 per cent; Soviet Union, 20 per cent; United Kingdom, 9 per cent; and the Netherlands, 6 per cent.[152] It was also agreed that none of the States would increase the number of factory ships it operated in the Antarctic, except by purchase of a factory ship engaged in Antarctic pelagic whaling at the time of the purchase, along with part of the seller's quota.[153] The Soviet Union, however, was permitted to add one factory.[154]

"Public outcry over the decimation of the world's whale stock resulted in the establishment of a committee of neutral expert population dynamists to examine all relevant data and make recommendations to the Commission."[155] Their two reports resulted in Commission action reducing the quota to 3,500 blue whale units for the 1966/67 season and 3,200 units for the 1967/68 season, totals higher than those recommended by the scientists.[156] Japan, Norway, the Soviet Union and the United Kingdom agreed to allocate the 3,200 units for the 1967/68 season as follows: Japan, 46.66 per cent; Soviet Union, 30.48 per cent; and Norway, 22.86 per cent.[157]

While Antarctic whaling has been its principal concern, the Commission has also been unable to obtain agreement on necessary measures to control whaling in the north Pacific, the only important area outside the Antarctic for baleen whales, and an area which is also presenting exceedingly different problems.

G. International Convention for the Conservation of Atlantic Tunas

This Convention has not yet come into force. It has been signed by Brazil, Gabon, Japan, Republic of Korea, Spain and the United States. The United States ratified it on May 18, 1967. Japan, Ghana and South Africa have also ratified or otherwise adhered to the Convention. It will not come into force until seven instruments of ratification, approval or adherence are deposited with the Director General of the United Nations' Food and Agriculture Organization (FAO). It is open for signature by any government which is a member of the United Nations or of any of its specialized agencies.

1. Objectives

In 1960, a Symposium on African Tuna was held in Dakar, Senegal, under the auspices of the Commission for Science and Technology of the States South of the Sahara (CCTA). A group of representatives from West African nations called for the establishment of an international commission to manage Atlantic Ocean tuna along the lines of the American Tropical Tuna Convention. CCTA requested the UN Secretary-General to implement the suggestion and he referred the matter to FAO.

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[150] Convention, Art. V (2) (c).

[151] Oda, International Control of Sea Resources 81 (1963).

[152] Arrangements for the Regulation of Antarctic Pelagic Whaling, Art. IV, Thirteenth (1962) Annual Report of International Commission on Whaling, Appendix V, at 34.

[153] *Ibid.*

[154] *Ibid.*

[155] Chapman, *supra* note 107, at 21.

[156] *Ibid.*

[157] Commercial Fisheries Review, Vol. 29, No. 11, November 1967, at 34. Neither the Netherlands nor the United Kingdom is engaged in Antarctic whaling any longer. The nations involved were unable to agree upon national quotas for the 1966/67 season.

FAO appointed a working Party for Rational Utilization of Tuna Resources in the Atlantic Ocean. Ultimately, a Conference was convened under FAO auspices in Rio de Janeiro in 1966 and it produced the Convention.

The Convention covers "all waters in the Atlantic Ocean, including the adjacent seas."[158] This wide coverage is essential because the stocks of tuna fished off West Africa are likely to migrate across the entire Atlantic and are heavily exploited by vessels from countries of North America, South America, Europe, Africa, and Asia. It is also clear that the language of the Convention was intended to cover the territorial seas and other waters over which the nations otherwise claimed exclusive jurisdiction.

2. Administrative Organization and Powers

The States Parties agree to establish and maintain an International Commission for Atlantic Tunas, to be composed of not more than three delegates of each Party, assisted by experts and advisors.[159] Decisions of the Commission are to be made by a majority of the Parties voting, with each Party having one vote and with two-thirds of the Parties constituting a quorum.[160] The Commission is to elect a Chairman, a first Vice-Chairman and a second Vice-Chairman who shall not be re-elected for more than one term.[161]

The Chairman and the Vice-Chairman of the Commission together with the representatives of not less than four and not more than eight Parties elected at each regular meeting of the Commission are to constitute the Commission's Council.[162]

However, if at any time the number of the Parties exceeds 40, the Commission may elect an additional two Parties to be represented on the Council.[163] The Parties of which the Chairman and the Vice-Chairman are nationals shall not be elected to the Council.[164] The Council is to perform such functions as are assigned to it by the Convention or the Commission, and shall meet at least once in the interim between the regular meetings of the Commission.[165]

The Commission is also empowered to appoint an Executive Secretary to serve at its pleasure. The Executive Secretary, subject to the rules and procedures prescribed by the Commission, shall select and supervise the Commission's staff. He shall also perform, among other things, the following functions:

(a) coordinate the programs of investigation by the Parties;

(b) prepare budget estimates for review by the Commission;

(c) authorize disbursement of funds in accordance with the budget;

(d) account for the funds of the Commission;

(e) arrange for cooperation with other organizations;

(f) prepare the collection of and the analysis of data necessary to accomplish the purpose of the Convention, especially those data relating to current and maximum sustainable catches of tuna stocks; and

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[158] Convention, Art. I. Copy of Convention provided by United States Department of State. See also Carroz and Roche, The Proposed International Commission for the Conservation of Atlantic Tunas, 61 Am. J. Int'l. L. 673 (1967).

[159] *Id.*, Art. III.

[160] *Ibid.*

[161] *Ibid.*

[162] *Id.*, Art. V.

[163] *Ibid.*

[164] *Ibid.*

[165] *Ibid.*

(g) prepare for approval by the Commission scientific, administrative and other reports of the Commission and its subsidiary bodies.[166]

The Commission itself is entrusted with the following functions:

(a) Study the populations of tuna and tuna-like fisheries and such other species of fish exploited in tuna fishing in the Convention area as are not under investigation by some other international organization. The study shall include research on fishery abundance, biometry and ecology of the fish, the oceanography of their environment; and the effects of natural and human factors upon their abundance.[167]

The methods of the study shall include: (i) collecting and analyzing statistical information relating to the current conditions and trends of the tuna fishery resources of the Convention area; (ii) studying and appraising information concerning measures and methods to insure maintenance of the populations of tuna and tuna-like fishes in the Convention area at levels which will permit the maximum sustainable catch and which will insure the effective exploitation of these fishes in a manner consistent with this catch; (iii) recommending studies and investigations to the States Parties; and (iv) publishing and otherwise disseminating reports of its findings and statistical, biological and other scientific information relative to the tuna fisheries of the Convention area.[168]

In conducting these studies, the Commission shall utilize the technical and scientific services of and information from official agencies of the Parties and may, when desirable, utilize the available services and information of any public or private organization or individual. However, it may also undertake, within the limits of its budget, independent research to supplement the research work being done by governments, national institutions or other international organizations.[169]

(b) Establish Panels on the basis of species, groups of species or geographic areas, to be responsible for (i) keeping under review the species, groups of species, or geographical area under its purview, and for collecting scientific and other information relating thereto; (ii) proposing to the Commission, upon the basis of scientific investigations, recommendations for joint action by the Parties; and (iii) recommending to the Commission studies and investigations necessary to obtain information regarding its species, groups of species, or geographic area, as well as measures to coordinate the programs of investigations by the Parties.[170]

(c) On the basis of scientific evidence, make recommendations designed to maintain the populations of tuna and tuna-like fishes that may be taken in the Convention area at levels which will permit maximum sustainable catches.[171] These recommendations shall be made (i) at the initiative of the Commission if an appropriate Panel has not been established or with the approval of at least two-thirds of all Parties if an appropriate Panel has been established; (ii) at the initiative of an appropriate Panel if such a Panel has been established; or (iii) at the initiative of the appropriate Panels if the recommendation in question relates to more than one geographic area, species or group of species.[172]

Each Commission recommendation shall become effective for all Parties six months after the date of the notification from the Commission transmitting the recommendation to the Parties.[173] But a procedure is laid down under which any Party may object to a recommendation and not have the recommendation bind it.[174] Furthermore, if objections are presented by a majority of the Parties, the recommendations shall not become effective as to any Party, but if presented by less than a majority, the recommendation shall become effective for the non-objecting Parties.[175]

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[166] *Ibid.*

[167] *Id.*, Art. IV.

[168] *Id.*, Art. V.

[169] *Id.*, Art. IV.

[170] *Id.*, Art. VI.

[171] *Id.*, Art. VIII.

[172] *Id.*, Art. VIII (1) (b).

[173] *Id.*, Art. VIII (2).

[174] *Id.*, Art. VIII (3).

3. Budget[176]

The Convention fixes a uniform fee of $1,000.00 for membership in the Commission and another fee of $1,000.00 for each Panel membership. It further provides for a supplementary budget in the event that the proposed budget for joint expenses, approved by all Parties present and voting, exceeds the usual contributions made by the States. The supplementary budget is then to be apportioned as follows.

Parties contribute to the first third of the supplementary budget in proportion to their contributions to the fixed part of the budget (the fees specified above). Contributions to the other two-thirds are calculated on the basis of each Party's "round weight" of catches of Atlantic Tuna and tuna-like fishes and the net weight of canned products of such fishes, relative to the sum of these weights for all the Parties.

While these provisions protect Parties from liability for payment of higher contributions than they are willing to make, they enable a single Party to veto any supplementary budget. The financial clauses indicate that the Commission will most likely be forced to depend on research efforts of each Nation's scientists.

4. Enforcement

The Parties agree to take all steps necessary to ensure the Convention's enforcement, and to report to the Commission the actions they have so taken.[177]

Furthermore, the Parties agree to set up a system of international enforcement to be applied in the Convention area, except the territorial seas and other waters, if any, in which a State Party is entitled under international law to exercise exclusive jurisdiction over fisheries.[178] But it is left open whether the enforcement system is to include the exercise of police powers by the Commission itself or whether the individual Parties will exercise such powers with respect to each other.

H. United Nations Fishery Organizations

1. The Food and Agriculture Organization (FAO) and Related Organizations[179]

On January 1, 1966, the Department of Fisheries of the FAO was established, headed by an Assistant Director-General for Fisheries and consisting of the Fishery Resources and Exploitation Division and the Fishery Economic and Products Division. The Department replaced, in a revised, broadened and strengthened form, the Division of Fisheries which was part of FAO since the latter organization was formed in 1945. The Department was formed to give the problems of fisheries greater attention in an organization then dominated by concern for agriculture on land. It is also responsible for the administration of technical assistance to, and special projects in, developing countries, designed to improve their fishery capabilities.

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[175] *Id.*, Art. VIII (3) (f), (g).

[176] *Id.*, Art. X.

[177] *Id.*, Art. IX.

[178] *Ibid.*

[179] Unless otherwise indicated, the following account is based upon Report of the UN Secretary General, *supra* note 120, Annex XI, at 11-14.

To further reflect the increasingly important role of food from the sea in the world diet, a Committee on Fisheries, consisting of representatives of 30 member nations, was set up to review the work of the Department of Fisheries, to deal with fishery problems of an international character and to promote international cooperation in fisheries. Among its members are the senior fishery officials of all the important fishing nations of the world, except the Soviet Union.

At its first meeting in Rome, December 5-17, 1966, the Committee on Fisheries undertook to assess the effectiveness of existing arrangements for international fisheries management, including the existing regional fishery commissions. The Committee has also considered problems of the rational utilization of the pelagic fishery resources of the Indian Ocean, the fisheries of the Middle and South Atlantic and marine pollution.

In connection with FAO's preparation of an Indicative World Plan for Agricultural Development, the Department of Fisheries has undertaken to provide material on potential production of food from the oceans and inland waters.

FAO also operates through numerous sub-bodies:

–Indo-Pacific Fisheries Council (IPCF)

–General Fisheries Council for the Mediterranean (GFCM)

–Southwest Atlantic Fisheries Advisory Commission (CARPAS)

–Indian Ocean Fisheries Commission

–Fishery Committee for the Eastern Central Atlantic

–Advisory Committee on Marine Resources Research (ACMRR)

We describe below those FAO related organizations to which the United States belongs.

It was generally thought that the original FAO Fisheries Division was not effective as a coordinating body for fisheries research or development of world fisheries. Some optimism, however, has been expressed by United States officials about the prospects of the FAO Fisheries Department.[180] These prospects may be somewhat dimmed by the fact that the Soviet Union is not a member of FAO. However, the Ministry of Fisheries of the Soviet Union is cooperating with the FAO Department of Fisheries.

Nevertheless, men acquainted with the FAO's work in fisheries continue to express doubt that it will ever be as effective as it should be, so long as it remains within FAO which, it is claimed, is dominated by interests primarily concerned with land agriculture.

In fiscal year 1968, the United States contributed $811,472 to the fisheries work of FAO.[181] In fiscal year 1969, its contribution was increased to $1,025,082 and this same amount is expected to be contributed in fiscal year 1970. In each of these years, the United States contribution accounted for approximately 30 per cent of the total FAO expenditures on fisheries, which amounted to $2,543,800 in fiscal year 1968, $3,213,425 in fiscal year 1969 and $3,213,425 (expected) in fiscal year 1970.

In addition, the United States contributed $3,400,000 to the UN Development Program work in fisheries administered by FAO in each of the fiscal years 1968 and 1969 and is expected to contribute the same amount in fiscal year 1970. This contribution will account for 40 per cent of the total expenditures for this purpose of $8,500,000 in each of the fiscal years in question.

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[180] McKernan, *supra* note 106, at 12-13.

[181] The data in the text were supplied by the Department of State.

a. Agreement for the Establishment of the Indo-Pacific Fisheries Council[182] *(1.) Objectives* The purpose of this agreement is to establish a constitution for international cooperation in the development and proper utilization of the living aquatic resources of the Indo-Pacific areas.[183]

The States Parties to the Agreement are—Australia, Burma, Cambodia, Ceylon, France, India, Indonesia, Japan, Korea, Malaysia, the Netherlands, Pakistan, Philippines, Thailand, United Kingdom, United States, and Vietnam.

(2.) Administrative Organization and Powers The States Parties agree to establish, within FAO's framework, the Indo-Pacific Fisheries Council, composed of FAO members and those associate members of FAO and United Nations members not FAO members which apply for admission and are admitted by a two-thirds vote of the Council membership.[184] Decisions of the Council are taken by a majority of the votes cast, with each member having one vote, unless a greater majority is required by the Agreement or the Council's procedural rules.[185] The Council elects a Chairman and a Vice-Chairman at each regular session and they serve until the end of the next regular session.[186]

FAO provides the Secretary for the Council and the FAO Director-General appoints its Secretary who is administratively responsible to him.[187]

The following functions and duties, limited to the Indo-Pacific area, are entrusted to the Council:

(a) To formulate the oceanographical, biological, and other technical aspects of the problems of development and proper utilization of living aquatic resources;

(b) To encourage and co-ordinate research and application of improved methods in every day practice;

(c) To assemble, publish or otherwise disseminate oceanographical, biological, and other technical information relating to living aquatic resources;

(d) To recommend to Members such National or co-operative research and development projects as may appear necessary or desirable to fill gaps in such knowledge;

(e) To undertake, where appropriate, co-operative research and development projects directed to this end;

(f) To propose, and where necessary to adopt, measures to bring about the standardization of scientific equipment, techniques, and nomenclature;

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[182] At its third session in 1947, the FAO Conference recommended that the FAO should take the initiative in creating regional councils for the scientific exploration of the sea in parts of the world not then served by similar bodies, giving special attention to the Northwestern Atlantic, the Southwestern Pacific, the Indian Ocean, the Mediterranean Sea and contiguous waters, the Northeastern Pacific, the Southeastern Pacific, the Western South Atlantic, and the Eastern South Atlantic. The first product of the recommendation was the formation of the Indo-Pacific Fisheries Council in 1948. T.I.A.S. No. 1895.

The agreement creating the Council was subsequently amended. The latest amended agreement entered into force for the United States, Nov. 23, 1961, 13 U.S.T. 2511, T.I.A.S. No. 5218, 418 U.N.T.S. 348. The agreement was further amended at the Ninth Session in Karachi in 1961. These amendments were approved at FAO's Eleventh Session in Rome and entered into force for the United States, Nov. 23, 1961. 13 U.S.T. 2511, T.I.A.S. 5218.

The Agreement provides that Members of the Council may amend it by a two-thirds vote. An amendment becomes effective only after concurrence of the FAO Council, unless the Council considers it desirable to refer the amendment to the FAO Conference for approval. An amendment becomes effective as from the date of the decision of the FAO Council or Conference, as the case may be. However, any amendment involving new obligations for members comes into force with regard to each Member only on acceptance of it by that Member. Agreement, Art. VIII.

[183] Agreement, Preamble.

[184] *Id.*, Art. I (2), IX. This provision was intended to induce the Soviet Union to join.

[185] *Id.*, Art. II (2).

[186] *Id.*, Art. II (3).

[187] *Id.*, Art. II (6).

(g) To extend its good offices in assisting its Members to secure essential material and equipment;

(h) To report upon such questions relating to oceanographical, biological, and other technical problems as may be recommended to it by Members or by the FAO or other international, national or private organizations with related interests;

(i) To transmit biennially to the FAO Director-General a report embodying its views, recommendations, and decisions, and make such other reports to the FAO Director-General as may seem to it necessary or desirable.[188]

(3.) Budget Each member government undertakes to pay the expenses of its delegates, alternates, experts, and advisors arising out of the attendance at Council sessions, the expenses of its representatives on Council committees and working Parties and the expenses of research or development projects undertaken by it, even upon the Council's recommendation.[189] The expenses of the Secretariat, including publications and communications, and of the Chairman, Vice-Chairman and the immediately retired Chairman of the Council (who act as Council's Executive Committee), when performing duties connected with its work during intervals between its sessions, are budgeted and paid by FAO.[190] The expenses incurred in connection with co-operative research or development projects are paid by the Members in the form and proportion to which they agree.[191] The expenses of experts invited, with the concurrence of the FAO Director-General, to attend meetings of the Council, committees or working Parties in their individual capacity are budgeted and paid by FAO.[192]

(4.) Dispute-Settlement Machinery Any dispute regarding the interpretation or application of the Agreement, if not settled by the Council, must be referred to a committee composed of one member appointed by each of the Parties to the dispute and in addition an independent chairman chosen by the members of the committee. The recommendations of such a committee, while not binding in character, become the basis for renewed consideration by the Parties concerned with the matter giving rise to the disagreement. If as a result of this procedure the dispute is not settled, it shall be referred to the International Court of Justice in accordance with the Statute of the Court, unless the Parties to the disagreement agree to another method of settlement.

(5.) Activities The Council, of course, has no regulatory powers, but coordinates and reports on research carried on by members in the area.

b. Indian Ocean Fishery Commission and Fishery Committee for the Eastern Central Atlantic These are two newly formed FAO regional fishery bodies which, as of September 1, 1968, have not had their first meetings, but which the United States will join.

c. The Advisory Committee on Marine Resources Research[193] The Advisory Committee (ACMRR) was established by FAO in 1961. It is composed of a group of experts, appointed in their individual capacity, to advise FAO on marine fishery research and dissemination, interpretation and application of the results of such research, with special attention to the fishery aspects of oceanographic research, for which ACMRR also serves as advisory body to UNESCO's Intergovernmental Oceanographic Commission (IOC).

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[188] *Id.*, Art. IV, V.

[189] *Id.*, Art. VII (1), (3).

[190] *Id.*, Art. VII (2).

[191] *Id.*, Art. VII (4).

[192] *Id.*, Art. VII (5).

[193] The following data are based upon Report of the UN Secretary General, *supra* note 120, Annex XI, at 17-19.

ACMRR has played a major role in the reorganization of fisheries affairs in FAO and in the development of international ocean activities undertaken through IOC.

2. The Educational, Scientific, and Cultural Organization[194]

Although UNESCO's Office of Oceanography and the Intergovernmental Oceanographic Commission (IOC) are not organizations specifically devoted to fisheries, they carry on important activities with relation thereto and, therefore, will be described briefly.

a. UNESCO's Office of Oceanography This Office forms part of UNESCO's Department of Advancement of Science. The Director of the Office is also, *ex officio,* Secretary of IOC. The Office "is concerned with stimulating and co-ordinating basic oceanic research and associated scientific work throughout the world and with providing technical assistance in oceanography to the developing countries." Its activities in oceanography include:

(1) Provision of secretarial services to IOC and support to the international scientific expeditions co-ordinated by IOC. It is expected that $225,000 will be allocated for these services and IOC support in 1969/70. The IOC secretariat annually coordinates National activities to the value of $15-20 million.

(2) Exchange of information and promotion of development of modern oceanographic methodology and instrumentation. $80,000 was budgeted for this program in 1967/68.

(3) Assistance to National and regional institutions and laboratories. About $500,000 a year is spent on this program which provides assistance in the form of expert advice, equipment, organization of meetings and various grants from both its regular program and funds for technical assistance administered by the United Nations Development Program (UNDP). Expenditure on existing UNDP fishery projects exceeds the total of all other international funds spent on marine problems, other than those spent on defense and on the actual exploitation of marine resources.

(4) Training and education in marine science. Total expenditures projected for fellowships in marine science for 1969/70 are $85,000. It should also be noted that funds for training and education are also expended by UNDP, FAO, World Meteorological Organization (WMO), and Economic Commission for Asia and the Far East (ECAFE).

b. Intergovernmental Oceanographic Commission (IOC) IOC's particular function, as set forth in its governing statute approved by the XIth General Conference of UNESCO (1959) is "to promote scientific investigation with a view to learning more about the nature and resources of the oceans, through the concerted action of its members."

At present, IOC has 59 members; its membership is open to all States Members of the United Nations willing to participate in oceanographic programs that require concerted action by them.

IOC is responsible for organizing through World Data Centers the international exchange of oceanographic data; as well as organizing cooperative scientific expeditions. It sponsored the International Indian Ocean Expedition (1959-1965); the International Co-operative Investigations of the Tropical Atlantic (1963-1964); the Co-operative Study of the Kuroshio and Adjacent Regions of the Pacific; Co-operative Investigations in the Mediterranean; Co-operative Investigations of the Caribbean and Adjacent Regions; Cooperative Systemic Studies in the North Atlantic; and Comprehensive Studies of the Southern Ocean. Member States pay for their own participation in these cooperative programs.

Two scientific advisory bodies assist IOC in its work–(1) the Scientific Committee on Oceanic Research (SCOR) of the International Conference of Scientific Unions (ICSU), which is a non-governmental group with close contacts with working scientists; and (2) Advisory Committee on Marine Resources Research (ACMRR) of FAO, which was created to insure that fisheries interests are taken into account when basic studies of the ocean are planned.

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[194] The following material and quotations are from *id.* at 53-54, Annex XI, at 19-32.

At the January 3-February 2, 1967 meeting in Monaco of IOC's Bureau and Consultative Council, the Soviet Union proposed the immediate formation of a special working group on legal aspects of studies of the ocean and utilization of oceanic resources.

At its October 1967 meeting, the IOC passed three resolutions:

(1) Resolution V-6 established an IOC Working Group on Legal Questions Related to Scientific Investigations of the Ocean. This Group was charged with:

(a) Considering legal aspects specifically related to scientific investigations of the nature and resources of the ocean, including those related to the use of various means of collecting ocean data, with a view to indicating legal principles which should facilitate and guide such research, carrying out this work in coordination with the activities of the group of experts established at the 6th Meeting of the Bureau and the Consultative Council to prepare documentation concerning the legal aspects of the use of ocean data stations;

(b) Preparing documentation concerning the effect of the law of the sea on scientific research and proposals relating both to the contribution of scientific knowledge to the development of the law of the sea, and to the participation of the IOC in the deliberations of the United Nations and appropriate specialized bodies to assist them in taking proper account of scientific interests and scientific knowledge in the consideration of the further development of the law of the sea;

This resolution also advised the United Nations of IOC's readiness:

to assist in the acquisition and distribution of scientific knowledge, including knowledge of the effect of marine activities on the ocean environment, necessary for the optimum use of the seas in the interest of mankind and, where required, for the sound development of the law of the sea.

(2) Resolution V-19 recommended:

that the organizations of the UN family involved or interested in pollution problems explore the possibility of forming a joint group of experts to ensure that necessary scientific information is available to those agencies responsible for conservation of resources, pollution control and abatement

and instructed

the IOC Working Group to continue development of programs on the oceanographic research aspects of marine pollution, including monitoring aspects. If an alternative scientific group under the joint sponsorship of the interested UN organization were to be established, the IOC would have to reconsider the position of its working group on marine pollution.

This position is embodied in the Report and Recommendations of the IOC Working Group on Marine Pollution which the IOC accepted "with minor modifications."

(3) Resolution V-22 called for the establishment of an IOC Working Group on Training and Education in which SCOR and AMCRR representatives would be invited to participate. The resolution indicated that the terms of reference of the Working Group might include the following:

(a) To review the present state of various activities in oceanographic training and education as carried out by UNESCO, by other international organizations and by bilateral and multilateral training projects of Member States;

(b) To propose to UNESCO training programs directed to the particular needs of a region, and

(c) To advise UNESCO on the preparation of teaching manuals for various training levels, taking into account differences between countries in the availability of certain kinds of equipment;

(d) To ensure that Member States become aware of training courses and training facilities in the various regions;

(e) To study ways and means of facilitating placement for adequate oceanographic work of ex-fellows in their home countries.

In his report on *Marine Science and Technology*, the UN Secretary General proposed "as a matter of urgency" that the base of IOC be broadened "so as to enable it to formulate and co-ordinate the expanded programme" he recommended for international cooperation to acquire a better understanding of the marine environment through science.[195] Among other things, the Secretary General called for (i) appropriate modification of the IOC statutes; and (ii) adequate joint financial support by the UN agencies concerned (UNESCO, FAO, WMO) for the broadened IOC; (iii) appropriate direct financial support to IOC by the Member Governments.[196]

Meeting in June 1968, the IOC's Bureau and Consultative Council set up a small group of consultants, consisting of the Bureau itself and representatives from SCOR, ACMRR, UNESCO, FAO and WMO, to meet in September-October 1968 to formulate in detail a recommended framework for the broadened IOC and its Secretariat for presentation to the 9th Meeting of the Bureau and Consultative Council in early 1969.[197]

At the same time, the Bureau and Consultative Council requested the IOC Chairman to inform the UN Secretary General that IOC "is prepared to play a leading role for the planning, development, implementation and coordination of" the expanded program envisaged by the Secretary General.[198] Member Governments and other international organizations were also invited to submit their proposals for such an expanded program for consideration at the 9th Meeting of the Bureau and Consultative Council.[199]

In response to this invitation, the United States urged that IOC "should be recognized and supported as the focal point within the UN system for ocean science . . . and should be substantially independent in carrying out its programs . . ."[200] Accordingly, the United States suggested that consideration should be given by UNESCO to transferring its Office of Oceanography to IOC and charging IOC with carrying out the UNESCO oceanographic program.[201] This suggestion reflects a commonly held view on the part of those who have been active in IOC's work that IOC suffers from being part of UNESCO which is dominated by educators not particularly interested in marine science.

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[195] Report of the UN Secretary General, *supra* note 120, at 76-79.

[196] *Id.* at 77.

[197] Eighth meeting of the IOC Bureau with the Consultative Council, Recommendation 8.4 (London, June 10-14, 1968).

[198] *Id.*, Recommendation 8.18.

[199] *Ibid.*

[200] United States Comments and Suggestions to the IOC in Response to IOC B & CC Recommendations in Connection with the Report and Proposals Prepared by the UN Secretary General under UNGA Resolution 2172 (E/4487) Relating to Broadening and Strengthening of IOC.

[201] *Ibid.* The United States also advanced proposals to revamp IOC's administrative structure.

In each of the fiscal years 1968 and 1969, the United States contributed $117,200 to UNESCO's oceanographic work, including IOC.[202] In fiscal year 1970, it is expected that this contribution will be increased to $131,736. In each of these years, the United States contribution will amount to approximately 30 per cent of UNESCO's budget in this area, which totalled $391,460 in each of the fiscal years 1968 and 1969 and is expected to total $440,000 in fiscal year 1970.

In addition, the United States contributed $76,805 in fiscal year 1968 and $113,680 in fiscal year 1969 to the oceanographic work of the UN Development Program (including UN Technical Assistance and UN Special Fund) administered by UNESCO. In fiscal year 1970, the United States contribution is expected to remain at $113,680. In each of these fiscal years, the United States contribution accounted for 40 per cent of the total expenditures for the purposes indicated, which amounted to $192,015 in fiscal year 1968, $284,200 in fiscal year 1969 and $284,200 (anticipated) in fiscal year 1970.

II. BILATERAL AGREEMENTS TO WHICH UNITED STATES IS A PARTY

A. Convention Between the United States and Canada for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea[203]

1. Objectives

The purpose of this Convention is "to develop the stocks of halibut in the Convention waters (the territorial waters and the high seas off the western coasts of the United States and Canada, including the southern as well as the western coasts of Alaska) to those levels which will permit the maximum sustained yield and to maintain the stocks at those levels."[204]

2. Administrative Organization and Powers

The Parties agree to continue the International Pacific Halibut Commission, composed of six members, three appointed by each Party.[205] Decisions of the Commission are made by a concurring vote of at least two of the Commissioners of each Party.[206]

The Commission is entrusted with the following functions:

a. To make such investigations as are necessary into the life history of the halibut in the Convention waters and publish a report of its activities and investigations from time to time.

b. After its investigation has indicated such action to be necessary and with the approval of the President of the United States and the Governor General and Council of Canada, to take the following actions:

(1) divide the Convention waters into areas;

(2) establish one or more open or closed seasons, as to each area;

(3) limit the size of the fish and the quantity of the catch to be taken from each area within any season during which fishing is allowed.

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[202] The data in the text were supplied by the Department of State.

[203] This Convention was originally signed at Washington, March 2, 1923; continued by the Convention signed at Ottawa, May 9, 1930; and further continued by the Convention signed at Ottawa, Jan. 29, 1937. It was replaced by the Convention now in force signed at Ottawa, March 2, 1953, entered into force, Oct. 28, 1953, 5 U.S.T. 5, T.I.A.S. No. 2900, 222 U.N.T.S. 77.

[204] Convention, Art. I (1), (2).

[205] *Id.*, Art. III (1).

[206] *Ibid.*

(4) during both open and closed seasons, permit, limit, regulate or prohibit, the incidental catch of halibut that may be taken, retained, possessed or landed from each area or portion of an area by vessels fishing for other species of fish;

(5) prohibit departure of vessels from any port or place, or from any receiving vessel or station, to any area for halibut fishing, after any date when in the judgment of the Commission the vessels which have departed for that area prior to that date or which are known to be fishing in that area shall suffice to catch the limit set for that area;

(6) fix the size and character of halibut fishing appliances to be used in any area;

(7) make such regulations for the licensing and departure of vessels and for the collection of statistics of the catch of halibut as it shall find necessary to determine the condition and trend of the fishery and to carry out the other provisions of the Convention; and

(8) close to all taking of halibut such portion or portions of an area or areas as the Commission finds to be populated by small, immature halibut and designates as nursery grounds.[207]

The nationals and inhabitants and fishing vessels and boats of the United States and Canada, respectively, are prohibited from fishing for halibut in Convention waters, except as provided by the Commission in its regulations.[208]

3. Budget

Each Party undertakes to pay the salaries and expenses of its own commissioners, but joint expenses incurred by the Commission are shared equally by the two contracting Parties.[209]

For fiscal year 1969, the United States share of the joint expenses will total $206,000.[210]

4. Enforcement

The Parties agree to enact and enforce such legislation as may be necessary to make effective the provisions of the Convention and any regulation adopted thereunder with appropriate penalties for violations thereof.[211]

Furthermore, every national or inhabitant, vessel or boat of the United States or Canada engaged in fishing on the high seas in violation of the Convention or any regulation adopted pursuant to it, may be seized by the duly authorized officers of either of the Parties and detained by the officers making the seizure and delivered as soon as practicable to an authorized official of the country to which the violating person, vessel or boat belongs, at the nearest point to the place of seizure or elsewhere as may be agreed upon. The nation to which the offending person, vessel or boat belongs alone shall have jurisdiction to prosecute for the violation and to impose penalties.[212]

Finally, each Party is made responsible for the proper observance of the Convention and any regulations adopted thereunder in the portion of its waters covered thereby.[213]

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[207] *Id.*, Art. III (2).

[208] *Id.*, Art. I (1).

[209] *Id.*, Art. III (1).

[210] The data in the text were supplied by National Council on Marine Resources and Engineering Development, the Department of State and the Department of the Interior.

[211] Convention, Art. IV.

[212] *Id.*, Art. II (1).

[213] *Id.*, Art. II (2).

5. Activities

Under Commission management, the size of the halibut population has more than trebled—the permitted annual catch, which had declined to 44 million pounds by 1931, the year before effective regulatory powers were entrusted to the Commission, attained an all-time record of 75 million pounds in 1962 and was worth $22 million to the fishermen of the two countries.[214] It is estimated that the accumulated gains since 1931 have been worth more than $100 million to the two countries.[215] Permitted annual catches are close to the sustainable maxima.[216]

The principal method of regulation chosen by the Commission has been the imposition of total catch limits in specific areas and the prohibition of fishing (by shortening the season) once the limits are attained. However, it has also imposed size limits and restrictions on gear, particularly the prohibition of trawling for halibut.

Japan entered the eastern Bering Sea halibut fishery in 1963, after the International North Pacific Fisheries Commission decided that the abstention doctrine was inapplicable to that area.[217] However, since that time Canada, the United States and Japan have complied with INPFC's recommended regulations for the conservation of halibut in the area in question. In recent years, economic considerations have led the Japanese to withdraw from the halibut fishery in a considerable part of the Eastern Bering Sea.

A large foreign trawl net fishery has also developed in the Bering Sea and the Gulf of Alaska on grounds frequented by halibut.[218] This trawl fishing results in some destruction of small halibut.[219]

The Halibut Commission, very early in its existence, established an industry Advisory Committee even though its Convention does not expressly provide for one. Experience with the Advisory Committee was so beneficial that provision for such a Committee was incorporated in subsequent conventions.

B. Convention Between the United States and Canada for the Protection, Preservation and Extension of the Salmon Fishery of the Fraser River System[220]

1. Objectives

The purpose of the Convention, originally, was to restore and maintain the sockeye salmon fisheries in the Fraser River system which were in danger of being depleted.[221] In 1956, a Protocol amended the Convention to make it apply to pink salmon also.[222]

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[214] Statement of United States Senate Commerce Committee Staff. Treaties and other International Agreements etc., *supra* note 53, at 248.

[215] *Ibid.*

[216] *Ibid.*

[217] *Id.*, at 249. This followed the removal of halibut of the eastern Bering Sea from abstention by Japan under the International Convention for the High Seas Fisheries of the North Pacific Ocean.

[218] *Ibid.*

[219] *Ibid.*

[220] This Convention was signed at Washington, D.C., May 26, 1930, entered into force July 28, 1937, 50 Stat. 1355, T.S. 918, IV Trenwith 4002, 184 L.N.T.S. 305. A supplementary Agreement was reached to facilitate the ascent of salmon in Hell's Gate Canyon and elsewhere in the Fraser River system. Exchange of notes at Washington, July 21 and Aug. 5, 1944, entered into force Aug. 5, 1944, 59 Stat. 1614, E.A.S. 479, 121 U.N.T.S. 299.

[221] Convention, Preamble.

[222] The Protocol amending the Convention to include pink salmon in the Fraser River system was signed at Ottawa, Dec. 28, 1956, entered into force, July 3, 1957, 8 U.S.T. 1057, T.I.A.S. No. 3867, 290 U.N.T.S. 103.

2. Administrative Organization and Powers

The Parties agree to establish and maintain the International Pacific Salmon Fisheries Commission, consisting of six members, three appointed by the United States and three by Canada.[223] Decisions of the Commission are made by an affirmative vote of at least two of the Commissioners of each Party.[224]

In the 1937 Protocol of Exchange, the Parties agreed that the Commission shall establish an Advisory Committee composed of five persons from each country who shall be representatives of various branches of the industry.

The Advisory Committee would be invited to all non-executive meetings of the Commission and given full opportunity to examine and to be heard on all proposed orders, regulations or recommendations. The Protocol was later amended to provide that the Advisory Committee will be composed of six persons from each country.

The Commission is established with the following functions:

a. to make a thorough investigation into the natural history of the Fraser River salmon, into hatchery methods, spawning ground conditions and other related matters.[225]

b. to conduct salmon fish cultural operations in described waters and to that end to improve spawning grounds; construct and maintain hatcheries, rearing ponds and other such facilities as it may determine to be necessary for the propogation of salmon in any of the waters covered by such methods as it may determine to be most advisable.[226]

c. to recommend removing or otherwise overcoming obstructions to the ascent of salmon that may now exist or that may from time to time occur, if investigation shows that removal of, or other action to overcome, obstructions is desirable.

d. to make an annual report on the investigations which it has made and other actions which it has taken to discharge its functions.[227]

e. to limit or prohibit taking salmon in all or any of the Convention waters, which are described, provided that (1) no order limiting or prohibiting taking salmon adopted by the Commission shall be construed to suspend or otherwise affect the requirements of the laws of the State of Washington or of the Dominion of Canada as to the procuring of a license to fish in the waters on their respective sides of the boundary, or in their respective, specified territorial waters, and (3) any order adopted by the Commission limiting or prohibiting taking salmon on certain described high seas shall apply only to nationals and inhabitants and vessels and boats of the United States and Canada.[228]

f. to prescribe the size of meshes in all fishing gear and appliances that may be operated during the spring or chinook salmon fishing season in the waters of the United States and/or the Canadian waters covered by the Convention, in order to secure a proper escapement of salmon during that season.[229]

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[223] Convention, Art. II.

[224] *Id.*, Art. VI.

[225] *Id.*, Art. III.

[226] *Ibid.* Each party agrees to acquire and place at the disposition of the Commission any land in its territory required for the construction and maintenance of hatcheries, rearing ponds and other facilities. *Id.*, Art. VIII.

[227] *Ibid.*

[228] *Id.*, Art. IV.

[229] *Id.*, Art. V.

g. to prescribe, at all seasons of the year, the size of the meshes in all salmon fishing gear and appliances that may be operated on the described high seas, but these requirements shall apply only to nationals and inhabitants and vessels and boats of the United States and Canada.[230]

h. to regulate the fishery with a view to allowing, as nearly as practicable, an equal portion of sockeye salmon as may be caught each year and an equal portion of pink salmon as may be caught each year to be taken by the fishermen of each Party.[231]

All Commission regulations are subject to approval of the two governments except orders for the adjustment of closing or opening of fishing periods and areas in any fishing season and of emergency orders required to carry out the Convention provisions.[232]

3. Budget

Each Party undertakes to pay the salaries and expenses of its own Commissioners and to share equally the joint expenses incurred by the Commission.[233]

In fiscal year 1969, the United States will contribute $377,000 to the work of the Commission.[234]

4. Enforcement

The Parties agree to enact and enforce such legislation as may be necessary to make effective the provisions of the Convention and the Commission's orders and regulations, with appropriate penalties for violations.[235]

Each Party is made responsible for the enforcement of the orders and regulations adopted by the Commission in the portion of its waters covered by the Convention. On the described high seas, except as provided in Article IX, each Party is made responsible, in respect of its own nationals and inhabitants and vessels and boats, for the enforcement of the Commission's orders and regulations.[236]

Under Article IX, every national or inhabitant, vessel or boat of the United States or Canada, that engages in salmon fishing on the high seas covered by the Convention in violation of a Commission order or regulation, may be seized and detained by the duly authorized officers of either Party, and when so seized and detained, shall be delivered by the officers, as soon as practicable, to an authorized official of the country to which the offending person, vessel or boat belongs, at the nearest point to the place of seizure, or elsewhere, as may be agreed upon with the competent authorities. The nation to which the violating person, vessel or boat belongs, alone shall have jurisdiction to conduct prosecutions for violations and to impose penalties therefor.

5. Activities[237]

The Commission's initial task was to determine the cause of the decline of the sockeye runs to the Fraser River. At one time, this species of salmon was so abundant that in 1913 it produced a pack of almost a quarter of a billion one-pound cans which, in 1944 prices, was worth more than $40 million. By 1944, one-eighth of that amount was considered a good pack.

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[230] *Ibid.*

[231] *Id.*, Art. VII.

[232] *Id.*, Art. VI.

[233] *Id.*, Art. II, III.

[234] The data in the text were supplied by National Council on Marine Resources and Engineering Development, the Department of State and the Department of the Interior.

[235] Convention, Art. X.

[236] *Id.*, Art. VIII.

[237] Unless otherwise indicated, the account of the Commission's activities is taken from Statement by United States Senate Commerce Committee Staff, Treaties and other International Agreements . . . , *supra* note 53, at 237.

In 1944, the Commission completed its investigation showing that the obstruction at Hell's Gate was one of the principal causes of the decline and it recommended remedial works. Fishways were constructed at Hell's Gate during 1944-46; which provided the means of rebirth of the sockeye runs above Hell's Gate. Other natural obstructions were observed and a total of 15 fishways were built at a cost of approximately $1 million each for Canada and the United States. In addition, the Commission carefully regulated the fishing effort on the various runs as they pass through the fishery.

As a result of these activities, the sockeye runs have been restored to 58 per cent of their historical level–representing an annual increase in the canned salmon value of $15,537,170, half of which accrues to each country. From 1946-1962, United States fishermen took 30,102,000 sockeyes and Canadian fishermen, 30,053,000.

New problems are already appearing for sockeye and pink salmon as a result of the growth of population and industrial development within the Fraser River watershed. A five-year plan of construction was started in 1964 to provide artificial spawning channels and other works to protect runs affected by adverse environment, to supplement the production of sockeye runs where the lake rearing areas are not being fully utilized and to supplement pink salmon spawning areas of limited capacity.

C. Convention on Great Lakes Fisheries Between the United States and Canada[238]

1. Objectives

The purpose of this Convention is to coordinate the efforts of Canada and the United States "to determine the need for and the type of measures which will make possible the maximum sustained productivity in Great Lakes fisheries of common concern" and, particularly, "to eradicate or minimize the populations of the sea lamprey."[239]

2. Administrative Organization and Powers

The parties agree to establish and maintain a Great Lakes Fisheries Commission, to be composed of two national sections, each consisting of not more than four members.[240] Decisions or recommendations of the Commission require the approval of both national sections, with each section having one vote.[241] Each national section has an advisory committee for each of the Great Lakes.[242]

The Commission selects a Chairman from one national section and the Vice-Chairman from the other and the two offices alternate biennially between the two sections.[243] It also appoints an Executive Secretary who may be authorized by the Commission to appoint its staff.[244]

The Commission is entrusted with the following duties:

(a) to formulate a research program or programs designed to determine the need for measures to make possible the maximum sustained productivity of any stock of fish in the Convention Area which, in the

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[238] This Convention was signed at Washington, Sept. 10, 1954, entered into force for the United States, Oct. 11, 1955, 6 U.S.T. 2836, T.I.A.S. No. 3326, 238 U.N.T.S. 97.

[239] Convention, Preamble Art. 1.

[240] *Id.*, Art. II (1). The original article called for not more than three members. It was recently amended to provide for four members in each national section.

[241] *Id.*, Art. II (2).

[242] *Id.*, Art. II (3).

[243] *Id.*, Art. III (1).

[244] *Id.*, Art. III (6), (7).

opinion of the Commission, is of common concern to the fisheries of the United States of America and Canada and to determine what measures are best adapted for such purpose;

(b) to coordinate research made pursuant to such programs and, if necessary, to undertake such research itself;

(c) to recommend appropriate measures to the Parties on the basis of the findings of such research programs;

(d) to formulate and implement a comprehensive program for the purpose of eradicating or minimizing the sea lamprey populations in the Convention Area; and

(e) to publish or authorize the publication of scientific and other information obtained by the Commission in the performance of its duties.[245]

To perform its duties, the Commission is authorized to:

(a) conduct investigations;

(b) take measures and install devices in the Convention Area and the tributaries thereof for lamprey control;

(c) hold public hearings in the United States of America and Canada;

(d) in so far as feasible, make use of the official agencies of the Parties and of their Provinces or States and . . . . make use of private or other public organizations, including international organizations, or of any person;

(e) establish and maintain working arrangements with public or private organizations for the purpose of furthering the objectives of this Convention; and

(f) request the Parties to furnish such information pertinent to the Commission's duties as is practicable, but each Party may establish conditions regarding the disclosure of such information by the Commission.[246]

Finally, the Commission is empowered to make recommendations to or advise the Parties whenever it deems necessary on any matter relating to the Convention.[247]

3. Budget

Each Party pays the expenses of its own national section. Together, they bear the Commission's joint expenses in such form and proportion as they approve.[248]

For fiscal year 1969, the United States will contribute $1,031,000 to the work of the Commission, which is 68 per cent of the Commission's estimated total expenses of approximately $1,516,000.[249]

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[245] *Id.*, Art. IV.

[246] *Id.*, Art. V, VI, VII.

[247] *Id.*, Art. IX.

[248] *Id.*, Art. VIII.

[249] The data in the text were supplied by National Council on Marine Resources and Engineering Development, the Department of State and the Department of the Interior.

4. Enforcement

The Parties agree to enact such legislation as may be necessary to give effect to the Convention's provisions.[250]

5. Activities

The Commission has succeeded in effecting a sharp reduction, estimated at more than 80 per cent, in the adult sea lamprey population in Lake Superior.[251] Not as much progress has been made in Lake Michigan or Lake Huron.[252]

The Commission has also coordinated an experiment in the rehabilitation of lake trout stocks in Lake Superior carried out by state, provincial and federal agencies working through the Commission's Lake Trout Rehabilitation Committee.

D. Agreement Between the United States and Japan on King Crab[253]

Japan insists that king crabs are a high seas fishery resource, and that nationals and vessels of Japan are entitled to continue fishing for king crabs in the eastern Bering Sea. The United States, however, maintains that the king crab is a natural resource of the Continental Shelf over which the coastal State has exclusive jurisdiction, control and rights of exploitation. Nevertheless, because of the historical fact that nationals and vessels of Japan have over a long period of time exploited the king crab resource in the eastern Bering Sea, the Parties agreed, without prejudice to their respective positions, that the Japanese would continue catching the king crab in and near the waters which have been fished historically by Japan, *provided that* in order to avoid possible overfishing, the Japanese ensured that the annual commercial catch of king crabs by the nationals and vessels of Japan for 1965 and 1966 would be equivalent to 185,000 cases respectively of 48 one-half pound cans.

The two governments agreed to meet before Dec. 31, 1966 to decide upon future arrangements. The International North Pacific Fisheries Commission was asked to intensify its study of the king crab resource in the eastern Bering Sea in order to determine the maximum sustainable yield of the resource. In the meantime, the governments agreed to take certain conservational measures, including the prohibition of taking of certain king crabs and the limitation of fishing gear to pot and tangle net and, in certain waters, to pot alone.

E. Japanese–United States Fisheries Agreement[254]

In an exchange of notes signed at Tokyo May 9, 1967, the United States and Japan agreed that Japan would not fish within the 12-mile exclusive fishery zone of the United States, except in certain waters. The two countries also agreed to cooperate in the prevention of conflict of gear in certain areas outside the twelve mile fishing zone. The arrangements are to continue until Dec. 31, 1968, and in some areas, until May 31, 1969. The two governments agreed to meet before Dec. 31, 1968 to decide upon future arrangements.

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[250] Convention, Art. XI.

[251] Statement of United States Senate Commerce Committee Staff, Treaties and other International Agreements, *supra* note 53, at 256.

[252] *Ibid.*

[253] This Agreement was signed at Washington, Nov. 25, 1964, entered into force, Nov. 25, 1964, 15 U.S.T. 2076, T.I.A.S. No. 5688, 533 U.N.T.S. 31.

[254] Exchange of notes at Tokyo, May 9, 1967; entered into force, May 9, 1967, T.I.A.S. No. 6287.

F. Agreement Between United States and Soviet Union on Fishing Operations in the Northeastern Pacific Ocean[255]

1. Objectives

By an Agreement of December 14, 1964, the United States and the Soviet Union agreed that fishing operations in the northeast Pacific should be conducted with due consideration to the interest of both Parties; that measures should be taken to prevent damage to the fishing gear used by the fishermen of both countries; and that provision should be made for appropriate contacts between the representatives of both countries on questions related to the conduct of the fisheries.[256]

2. Substantive Provisions

In order to reduce incidents of damage to fixed fishing gear, the two countries agreed to:

a. encourage the use by its officials, fishing industry organizations and fishermen of devices, detectable both day and night, to mark the location of fixed fishing gear.

b. inform each other of the devices and the manner in which they are used.

c. promote the exercise of necessary caution on the part of persons responsible for the operation of vessels and gear so as to aid to the maximum extent practicable in timely detection of the vessels and gear of the other Party and prevention of damage thereto.[257]

d. not engage in fishing operations with mobile fishing gear in six described areas adjacent to the Island of Kodiak during the period July to October, inclusive of each year.[258]

G. Agreement Between the United States and the Soviet Union on King Crab Fishing on the United States Continental Shelf in the Eastern Bering Sea[259]

The two governments here agreed:

1. The king crab is a natural resource of the Continental Shelf over which the coastal State has sovereign rights for the purposes of exploitation and exploration in accordance with the provisions of Article 2 of the Convention on the Continental Shelf.

2. Nationals and vessels of the Soviet Union may carry out commercial fishing for king crab on the Continental Shelf of the United States for a period of two years in certain areas of the Bering Sea described in an Appendix to the Agreement, *provided that* the annual commercial catch by the Soviet nationals and vessels in such areas shall not exceed 118,600 cases of 48 one-half pound cans each in 1965 and 1966. When the agreement was extended for two years, the Soviet Union's quota was reduced to 100,000 cases.

3. Each government will apply certain conservation measures to its own nationals and vessels engaged in the king crab fishery in the Eastern Bering Sea. Either government shall, if requested by the other, provide opportunity for observation of the conduct of the enforcement of the provisions of the

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[255] This Agreement was signed at Washington, Dec. 14, 1964, entered into force Dec. 14, 1964, 15 U.S.T. 2179, T.I.A.S. No. 5703, 531 U.N.T.S. 213.

[256] Agreement, Preamble.

[257] *Id.*, Art. I.

[258] *Id.*, Art. IIA, B. Small shrimp craft are authorized to conduct trawling operations in these areas in such a way that they do not interfere with fixed gear in the areas. Art. IIC.

[259] This Agreement was signed at Washington, Feb. 5, 1965, entered into force, Feb. 5, 1965, 16 U.S.T. 24, T.I.A.S. No. 5752, 541 U.N.T.S. 97. The Agreement was extended for two years on Feb. 13, 1967, 18 U.S.T. 183, T.I.A.S. No. 6217.

Agreement and for that purpose shall permit duly authorized officers of the other government to board its vessels engaged in the king crab fishery in the Eastern Bering Sea. These officers will make a report on the results of their observations and their report will be forwarded to the flag government for appropriate action if that should be necessary.

4. The two governments are to continue and intensify their study of the king crab resources and will exchange annually the data resulting from the study including, to the extent possible, an estimate of the maximum sustained yield of the resource. The data will be prepared by each government in accordance with its own methodology. The two governments will also provide for the exchange of scientific personnel engaged in the study of the king crab resource.

H. Agreement Between the United States and the Soviet Union on Certain Fishery Problems in the Northeastern Part of the Pacific Ocean off the Coast of the United States[260]

This Agreement, of one year's duration, specified several areas seaward of the twelve mile line off the Oregon-Washington coast in which Soviet vessels would either refrain from fishing or from concentrating their efforts. In certain other areas off the Oregon-Washington coast, measures would be taken jointly and separately, to protect stocks of fish.

Additional protection would be provided for fishing gear of United States halibut fishermen, early in the halibut season, in areas near Kodiak Island, Alaska. Under the Agreement, Soviet vessels would transfer cargoes in several designated areas off Washington and Oregon and off Alaska in the nine-mile zone contiguous to the United States territorial sea. Soviet vessels would also continue to fish within the nine-mile zone for the duration of the Agreement in the two areas of the central and western Aleutians and a smaller area in the northern Gulf of Alaska. The Agreement also provides for cooperation in scientific research, exchange of scientific data and personnel, exchanges of fishermen and/or their representatives aboard vessels of the two countries, and general procedures for reducing conflicts between the vessels and gear of the two countries.

In December 1967, representatives of the United States and the Soviet Union began in Washington a review of these fishing agreements. The United States delegation sought expansion of the high seas areas off Oregon and Washington where Soviet fishing would not take place. Because of the growing king crab fisheries in Alaska, in areas other than Kodiak, the United States also sought seasonal protective measures to minimize gear conflict in these additional areas. Finally, the United States sought protection for the Kodiak crab fishery through expansion of closed areas and extension of the closure period.

The Soviet delegation took the position that the Soviet Union had not been adequately compensated for its concessions. It sought permission for Soviet fishing in the exclusive fisheries zone claimed by the United States.

Discussions were inconclusive. It was decided on Dec. 18, 1967 that the agreements should continue unchanged for another year.[261] Since the king crab quota arrangements in the eastern Bering Sea will come up at the same time, it was understood that all three agreements would be considered together.

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[260] This Agreement was signed at Washington, Feb. 13, 1967, entered into force, Feb. 13, 1967, 18 U.S.T. 190, T.I.A.S. No. 6218.

[261] Agreement on Extending Validity of Agreement of Feb. 13, 1967 between the United States and the Soviet Union on Certain Fishery Problems in the Northeastern Part of the Pacific Ocean off the Coast of the United States, signed at Washington, Dec. 18, 1967, entered into force Dec. 18, 1967, with exchange of letters relating thereto and to the Agreement of Dec. 14, 1964. T.I.A.S. No. 6409.

I. Agreement Between the United States and the Soviet Union on Fishery Operations in the Western Mid-Atlantic Ocean[262]

1. Objectives

The two governments expressed their agreement (which is to remain in force for one year) that the fisheries in the western areas of the high seas in the mid-Atlantic be conducted on a rational basis and, to this end, (a) to do so with due regard for the state of fish stock, as determined by scientific investigation, and with the aim of maintaining the maximum sustainable yield of the fisheries; and (b) to expand and coordinate fisheries research and the exchange of scientific data.[263]

2. Substantive Provisions

Accordingly, the Parties agree:

a. The competent agencies of both governments will insure (1) an exchange of scientific and statistical data, published works and other results of fishery research; (2) the holding of meetings of scientists and, in appropriate cases, the participation of the scientists of each government in fishery research conducted on research vessels of the other government; and (3) the conduct of proper fishery research as well as the development of the most rational fishing technology in accordance with a coordinated program which has been proposed by the scientists of both countries.[264]

b. To assure the reproduction and maintenance of fish stocks, appropriate measures will be taken to prevent their citizens and vessels from (1) fishing during the period of January 1 to April 1, both inclusive, of each year in a certain area of the high seas adjacent to the outer limit of the nine-mile exclusive fisheries zone of the United States so as to give red hake and silver hake access to their spawning grounds; (2) increasing their fish catch above the 1967 level in the waters located north of Cape Hatteras and west and south of sub-area five of the area governed by the International Convention for the Fisheries in the Northwest Atlantic; and (3) conducting specialized fishing for scup and fluke or increasing their incidental catch of scup and fluke in the waters specified above as south of sub-area five and north of Cape Hatteras.[265]

c. Fishing vessels of the Soviet Union may (1) fish during the period from January 1 to April 1 of each year in certain areas within the nine-mile fishery zone of the United States;[266] and (2) during the period from September 15 to May 15 of each year, conduct loading operations in certain areas within the nine-mile fishery zone of the United States.[267]

d. Each government will adopt such procedures for presenting crew lists and for the supply of water, fuel and provisions, and take other measures that will facilitate entry into its ports of fishing and fisheries research vessels of the other government, particularly under conditions of *force majeure.*[268]

3. Enforcement

While the Agreement contains no enforcement provisions, verification of Soviet compliance with the catch limit will be possible by checks on the number and size of Soviet vessels in the region. Low flying aircraft and helicopters will be able to determine whether the Russians are taking prohibited scup and fluke.

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[262] This Agreement was signed at Moscow, Nov. 25, 1967, entered into force Nov. 25, 1967, T.I.A.S. No. 6377.

[263] Agreement, Preamble.

[264] *Id.*, Art. I.

[265] *Id.*, Art. II.

[266] *Id.*, Art. IV.

[267] *Id.*, Art. III.

[268] *Id.*, Art. V, VI.

4. Significance of Agreement

Soviet fishing vessels ranging in size from relatively small side trawlers (125 feet-175 feet) to large factory ships have for some time fished in various waters off the United States coast. United States fishermen in the western mid-Atlantic area found their catch of fluke, scup, silver hake, and red hake decreasing. Stocks of red hake migrate offshore in the fall to spawn and congregate off the continental shelf from Corsair Canyon in the northeast to Norfolk Canyon in the south. The center of abundance of the red hake is about 100 miles southeast of New York City in the area of the Hudson Canyon.[269] Intensive fishing by large Soviet fleets, consisting of as many as 200 vessels, in this region during the three schooling months, when fish swim together in large numbers, is believed to have caused the decline in hake catches.[270]

In 1966, Senator Warren G. Magnuson of Washington requested the State Department to approach the Soviet Government concerning its fishing efforts on the West Coast, where local fishing interests were alarmed because of the heavy Soviet activity off the coasts of Oregon and Washington during the Spring of that year. When, in July 1966, the United States undertook conversations with Soviet fishery officials about these matters, it also brought up similar problems which had arisen in the Western Atlantic off the United States coast in the area between Cape Cod and Cape Hatteras. When an agreement for the West Coast was reached in January 1967, the Soviet Union was not prepared to deal with the Middle Atlantic problem, but agreed to talk about it at the annual meeting of ICNAF to be held in Boston in June 1967.

In June 1967 the Soviet Union was unwilling to come to an agreement concerning the middle Atlantic fishing area, but an arrangement was made for the two countries to meet in Moscow before the 1967-68 Russian fishing season opened.[271]

The meeting was held and, after lengthy negotiations, the one-year agreement was signed. The agreement is probably less than was hoped for by United States fishing interests, but it is generally regarded as a large step in the right direction.[272]

In the opinion of Ambassador McKernan, the Agreement is an example of how a coastal State, whose coastal fishing is adversely affected by high seas fisheries conducted by a distant water fleet, can cooperate with the nation conducting such high seas fisheries in reaching mutually satisfactory solutions which are preferable to drastic actions of a unilateral nature.[273]

J. Agreement Between the United States and Mexico on Traditional Fishing in the Exclusive Fishery Zones Contiguous to the Territorial Seas of Both Countries[274]

This agreement was made necessary by the laws passed in both countries in 1966 extending their exclusive fishery zones from 3 miles to 12 miles in the case of the United States and from nine miles to 12 miles in the case of Mexico. The agreement applies only to waters between the 9 mile and 12 mile line from the coast of the mainland and islands of each country. Each country is given the right to fish for species which it has historically fished in these waters of the other country.

The fisheries most importantly affected are the shrimp fisheries of the Gulf of Mexico, the tuna fisheries of the Pacific coast, and the fisheries for snapper, grouper and other market fish species on both coasts.[275] It was also agreed that the total catch of each of these fisheries by fishermen of each country in the exclusive fishery zone of the other during the five years beginning on Jan. 1, 1968, was not to exceed the total catch during the five years preceding that date.

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[269] National Fisherman, January 1968, p. 2.

[270] New York Times, Nov. 26, 1967, p. 1, col. 5.

[271] National Fisherman, January 1968, p. 2.

[272] *Ibid.*

[273] See Commercial Fisheries Review, January 1968, Vol. 30, No. 1, p. 1.

[274] Exchange of Notes at Washington, Oct. 27, 1967, entered into force January 1, 1968, T.I.A.S. No. 6359.

[275] National Fisherman, January 1968, at p. 2-C.

The agreement also provides for (1) the continuation of sport fishing by United States citizens in the Mexican exclusive fishery zone during the five years starting on Jan. 1, 1968; (2) an extensive exchange of data on the areas in which traditional fishing has been carried on and the volume of catch over the past five years, the number and types of vessels and fishing gear used, and the names of vessels that will operate under the terms of the agreement; (3) annual meetings to review the operation of the Agreement; (4) the exchange of annual reports on volumes of catch and areas fished; (5) cooperation in formulating and implementing a program of scientific research and conservation of the stocks of shrimp and fish of common concern off the coast of Mexico, pursuant to the Geneva Convention on Fishing and Conservation of the Living Resources of the High Seas, to which both nations are Parties.

Each nation will have responsibility for enforcing the Agreement within its own fishery zone.

III. MULTILATERAL AGREEMENTS TO WHICH UNITED STATES IS NOT A PARTY

There are a number of multilateral agreements affecting international fisheries to which the United States does not adhere–principally because of lack of sufficient interest in the area concerned. These include the General Fisheries Council for the Mediterranean, the Regional Fisheries Advisory Commission for the Southwest Atlantic, both of which are FAO sub-bodies, the International Commission for the Scientific Exploration of the Mediterranean Sea; the Northeast Atlantic Fisheries Convention; the European Fisheries Conference; the Joint Commission for Fisheries Cooperation; and the Convention for the International Council for the Exploration of the Sea (ICES).

Only ICES will be here described because the United States was once a member of ICES and plans to join again.[276]

ICES was formed in 1902.[277] Its original statutes were revised in 1950[278] and the latter were superseded when the Convention for the International Council for the Exploration of the Sea, which was signed Sept. 12, 1964, came into force on July 22, 1967.[279]

The States Parties to the convention are Belgium, Canada, Denmark, Finland, Federal Republic of Germany, France, Iceland, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, the United Kingdom, and the Soviet Union.[280]

Until the new convention, and despite its name, ICES was regional in scope. For over 60 years, its membership was limited to European governments whose nationals exploited the waters of the Northeast Atlantic. In recent years, however, ICES has enlarged its scope of interest and this is reflected in the new convention. Under the new convention, ICES "shall be concerned with the Atlantic Ocean and its adjacent seas, and primarily . . . with the North Atlantic."[281]

A. Objectives

ICES' principal function is to encourage investigations into the study of the sea and to coordinate the operations of the participating governments to this end.

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[276] Information supplied by Nation Council on Marine Resources and Engineering Development.

[277] Report of the UN Secretary General, *supra* note 120, Annex XII, at p. 2.

[278] Carroz and Roche, The Proposed International Commission for the Conservation of Atlantic Tunas, 61 Am. J. Int'l. L. 673, 675, n.8 (1967).

[279] *Ibid.*

[280] *Ibid.*

[281] Convention, Art. II.

B. Administrative Organization and Powers

Under the new convention, ICES shall have the following duties: (a) to promote and encourage research and investigation for the study of the sea, especially related to living resources; (b) to draw up programs required for this purpose and to organize such agreements with States Parties for such research and investigation as may appear necessary; and (c) to publish or otherwise disseminate results of research and investigations carried out under its auspices, or to encourage such publication.[282]

Each member country is represented by two delegates to ICES. Each member country is also entitled to appoint two members to each of the standing committees dealing with the following geographical areas and subject matters—the Gear and Behavior, Hydrography, Statistics, Fisheries Improvement, Demersal Fish (Northern), Demersal Fish (Southern), Pelagic Fish (Northern), Pelagic Fish (Southern), Shellfish and Benthos, Plankton, Anadromous and Catadromous Fish, Marine Mammals.[283]

ICES has a full time staff. Its secretariat includes a General Secretary, a Hydrographer, 10 other full time officers and four part-time assistants.[284] The staff coordinates research and organizes meetings, but actual research is carried out in laboratories of the member nations.

In essence, ICES is an informal forum in which individual scientists are offered opportunities to collaborate.

C. Budget

ICES operations are supported by small contributions of the member governments and others.

D. Activities

ICES has provided a working model for all international research councils, laying the foundation for the new fisheries and oceanographic sciences. All Fishery Conventions relating to the Northeast Atlantic up to, but not including, the 1964 European Fishery Convention, were based upon ICES recommendations.

ICES acts as scientific advisor to Northeast Atlantic Fisheries Commission (NEAFC) through a special Liaison Committee, and the Commission submits questions to the Council for advice. It also collaborates with ICNAF and FAO.

The increasing need for current and accurate assessments of the strength of each important stock of commercially exploitable species results in increasing demands on the international Statistical Service of ICES. Not only will even more detailed information be required in the future, but it is also essential to insure that the right type of information is collected. A very close operational liaison is necessary between the Statistical Service and the working groups of the fishery conventions which are in charge of stock assessments, and mainly because of this the Council recently decided to strengthen its Statistical Service by the appointment of a Statistical Officer.[285]

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[282] *Id.*, Art. I.

[283] Report of the UN Secretary General, *supra* note 120, Annex XII, at 3.

[284] *Id.*, Annex XII, at 2.

[285] *Id.*, Annex XII, at 6.

Appendix C Alternative Legal-Political Frameworks for Exploiting the Living Resources of the High Seas

I. GIVE EACH COASTAL STATE EXCLUSIVE ACCESS TO THE LIVING RESOURCES OF THE WATERS SUPERJACENT TO ITS CONTINENTAL SHELF

Existing claims to extended exclusive fisheries zones are sought to be justified essentially on the argument that if the geographical status of the coastal State warrants its control over the mineral and sedentary living resources of the continental shelf, it also warrants its control over the non-sedentary living resources of the superjacent waters. For the purpose, the continental shelf could be defined as the panel recommended for mineral resources exploration and exploitation, i.e., 200 meters or 50 nautical miles from the coast, whichever gives the coastal State the greater area for exclusive fisheries exploitation. In addition, to make this alternative workable, the coastal State could be given permanent, exclusive access to any fish stock, the bulk of which is centered in the waters superjacent to the continental shelf as thus defined, even though the stock is sometimes found in waters beyond.[1]

It is difficult to determine what percentage of the world's fish catch would thereby be allotted to the coastal States, but it is estimated that 75 percent of that catch is taken within 200 miles of land.

a. There are many arguments for this alternative–other than the analogy to the natural resources of the continental shelf.

(1) It will make possible more effective regulation to conserve the resources and to exploit them economically because the coastal State will be able to act unilaterally to safeguard its own interests.

However, it should be pointed out in reply, this is merely a potentiality. As Dr. W. B. Chapman has emphasized to us, the California sardine, the Atlantic and Gulf menhaden, the Atlantic and Gulf oyster, have been substantially depleted even though the United States has exclusive access to these species. The Pacific mackerel and Alaskan king crab are in similar danger. Peru and Chile have overfished the sperm whale in waters to which they claim exclusive access.

Furthermore, most developing coastal States do not have the scientific and technical competence necessary for effective regulation.

(2) It will remove the fears of developing coastal States that the status quo threatens their future access to the living resources of the high seas.

(3) It may moderate the conflict between the United States and Chile, Eduador and Peru. However, our recommended redefinition of the continental shelf would fall far short of satisfying the present claims of these countries.

(4) It cannot be said for certain what impact the alternative would have on United States fishermen. That would depend on estimates of (a) the quantity of fish now taken by foreigners in waters to which the United States would have exclusive access under the proposal; (b) whether United States fishermen would actually take the additional stocks thereby made available to them; (c) the quantity of fish now caught by United States fishermen in waters to which foreign coastal States would have exclusive access under the proposal; and (d) whether United States fishermen would be excluded from these waters by such States.

b. There are also many arguments against the alternative.

(1) The analogy to the mineral resources of the continental shelf is not apt. As we pointed out in Chapter III, the Truman Proclamation of 1945, which was the foundation for the subsequent Convention on the Continental Shelf, was justified on a number of grounds which are not applicable to living resources. It was justified on the ground that effective exploitation of the mineral resources of the continental shelf would require the cooperation and protection of the coastal State; but fishermen are

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[1] See Dodyk, Report on the International Law of Ocean Fisheries 144-45 (Prepared for National Council on Marine Resources and Engineering Development, 1967).

not so dependent on any particular coastal State. Furthermore, the Truman Proclamation laid the juridical basis for a new activity and divested no one of rights long enjoyed; but States have fished over the continental shelves of other States for centuries.

The Truman Proclamation was also justified on two geological grounds–the continental shelf may be regarded as an extension of the landmass of the coastal State and the mineral resources of the continental shelf frequently form a seaward extension of a pool or deposit lying within the territory of the coastal State. There is no similar connection with the coastal State's territory in the case of the living resources of the waters superjacent to the continental shelf nor do we need to give the coastal State exclusive access to these resources in order to avoid possible conflicting claims to the same asset.

Finally, the Truman Proclamation was justified on grounds of "self-protection" which compelled the coastal State to keep close watch over activities off its shores which are of the nature necessary for the utilization of mineral resources. However, fishing activities over the continental shelf do not pose similar security problems. They do not require the permanent installations which are needed for mineral resources exploitation; they take place only for limited periods of time and can be closely watched by the coastal State.[2]

For similar reasons, we do not think that the considerations which led the panel to recommend that only licensees of the coastal State shall have claims on their behalf for mineral resource exploration and exploitation in the intermediate zone registered with the International Registry Authority apply to fisheries in the superjacent waters.

(2) To give the coastal States permanent exclusive access to the living resources over the continental shelves, as well as to the natural resources on and under the continental shelves, runs the risk of encouraging them to take the additional step of declaring their "sovereignty" over these areas, i.e., their right to exclude *any* use of the continental shelf, its subsoil, the superjacent waters, the surface waters, and the air above, without their permission. Such a development would seriously damage the historic interest of the United States in the freedom of the seas for purposes other than exploitation of marine resources–especially navigation, military uses and scientific research.

(3) This alternative would not assure the most productive use of the living resources in the greatly expanded exclusive fisheries zones. The coastal States may not have the competence or the financial ability fully to exploit these resources. Their failure to do so would result in irretrievable losses of needed output.

In reply to this objection, Professor Dodyk has suggested that this alternative might be accompanied by recognition of a right of "innocent fishing" by foreign fishermen, i.e., the right of foreign fishermen to continue to exploit a fish stock which is unused or underutilized by the nationals of the coastal State, provided it does not interfere with fishing by coastal fishermen for other species because of either gear conflict or the upsetting of the ecological balance.[3] Dodyk also suggests that the coastal State might be permitted to impose taxes or fees on the foreign fishermen so long as they are not prohibitory or discriminatory, i.e., not out of line with taxes imposed on similar domestic fishing enterprises or on other industries.[4] On the other hand, he also recognizes that any tax will increase the cost of production and the price of fish and thereby discourage the production of oceanic living resources at the lowest possible cost.[5]

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[2] The Panel recognizes that the arguments which justify giving the coastal State permanent, exclusive access to the mineral resources of the continental shelf do not apply to the sedentary living resources of the continental shelf. The panel regards the provisions of the Convention on the Continental Shelf with respect to sedentary living resources as anomalous and without justification. However, the issue seems to be closed. See generally, McDougal and Burke, The Public Order of the Oceans 642-63 (1962); Hearings Before Senate Foreign Relations Committee on Conventions on the Law of the Sea, 86th Cong., 2d Sess. 108-09 (1960); Hearings Before House Committee on Merchant Marine and Fisheries, 88th Cong., 2d Sess. (1964).

[3] Dodyk, *supra* note 1, at 147, 129-36. Professor Dodyk would extend this right of innocent fishing to the existing exclusive fisheries zones, and even the territorial seas, of the coastal States. *Id.* at 130.

[4] *Id.* at 132.

[5] *Id.* at 133.

(4) The alternative is unfair to non-coastal States and to States with distant-water fishing fleets which possess the freedom to fish on the high seas, beyond the 12-mile limits, under existing international law and should not have to pay tribute to coastal States for continuing to exercise this freedom.

(5) Certain species of fish roam beyond the continental shelves and their conservation and economic exploitation will require international cooperation which may not be forthcoming so readily if the coastal States will be the predominant beneficiaries thereof.

II. GIVE THE UNITED NATIONS, IN THE NAME OF THE INTERNATIONAL COMMUNITY, TITLE TO THE LIVING RESOURCES OF THE HIGH SEAS BEYOND THE 12-MILE LIMIT

It will be recalled that this proposal was originally made by the Commission to Study the Organization of Peace and was endorsed by the United Nations Charter Commitee of the World Peace Through Law Center.[6] Under this proposal, a United Nations agency would be created to control and administer these living resources. It would be empowered either (a) to operate the fisheries itself and "to buy labor and capital in the cheapest markets and sell marine products in the dearest markets, returning its 'profits' in kind or in money to the members of the international community,"[7] or (b) to auction to the highest bidders licenses (exclusive rights) to exploit specified stocks of fish or specified areas of the high seas and to use the proceeds from the auctions for agreed-upon international purposes.[8]

a. The following arguments have been adduced in favor of these alternatives.

(1) By operating the high seas fisheries as sole entrepreneur, the United Nations agency would be in a position to maximize the economic return from their exploitation. Even if it adopted the auction-bidding alternative, it would be able to limit the number of licenses put up for auction to that which would maximize the economic return to all licensees. There would be the maximum incentive under either alternative to encourage technical innovation in fishing gear and craft and research into methods of maximizing fishery resources.

(2) The United Nations agency would become the single conservation authority for high seas fisheries and be able to assure against overfishing and consequent depletion of any species or stock.

(3) The United Nations agency would have the resources to employ the technical and scientific personnel needed to manage high seas fisheries effectively and, if it resorted to the auction-bidding alternative, to enforce its license terms.

(4) If accepted, it would induce coastal States to abandon claims to extended territorial seas and exclusive fisheries zones.

(5) It would solve the problem of new entrants which plagues existing international fishery arrangements. Every nation would have a chance to participate in the fisheries anywhere in the world—by offering the cheapest price for its capital and labor or the highest price for a fishing license. And all nations would benefit from the "profits" of the United Nations agency. Thus, this alternative would give practical effect to the principle that the living resources of the high seas are the common property of all nations.

b. The following arguments have been adduced against these alternatives:

(1) All the stated advantages assume that the United Nations agency will act in a certain manner, but there can be no guarantee that it will. To entrust any agency with a monopoly of the exploitation of the living resources of the high seas is to run very great risks unwarranted by the needs of the existing situation.

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[6] See Appendix A.

[7] Christy and Scott, The Common Wealth in Ocean Fisheries 29-40 (1965).

[8] This alternative was suggested by Francis T. Christy, Jr. at the Second Annual Conference on the Law of the Sea, Kingston, R.I. (June 26-29, 1967).

(2) The objective might be obviated by confining the United Nations agency to the auction-bidding alternative. However, because nations have radically different cost structures, market preferences and non-economic goals, it is doubtful that auction-bidding, with its attendant uncertainties, would result in an allocation of the living resources of the high seas that would be regarded as fair by all nations or would necessarily be economically efficient.

(3) The United Nations agency would have to recover its administrative costs and earn profits to expend for the internationally-agreed purposes. This would add to the cost of exploitation and militate against the objective of developing the living resources of the seas at the lowest possible cost.

(4) Economic efficiency in fisheries exploitation—the principal justification advanced for the comprehensive internationalization proposals in question—is not the sole or even paramount objective of the fishing policy of many nations. For example, in both the developing and the developed countries, fisheries are maintained to provide jobs for isolated sectors of the labor force. Other nations may be willing to sacrifice some net economic gain from fisheries to acquire a larger quantity of fish for export and improve their balance of payments situation.

(5) In reply to these objections, Christy and Scott suggest that the United Nations agency "could proceed slowly, dismantling earlier agreements, changing techniques, introducing new methods of control, and restricting entry at a pace acceptable both to the States providing the inputs and to those whose historic position in the region is being altered."[9] It could also, in the interest of accommodating goals other than economic efficiency, accept instructions from the international community "about fleets and equipment to be used, types of fish to be caught and ports to be employed."[10]

(6) The comprehensive internationalization proposals under consideration are not the only ways to attain the biological and economic objectives sought by Christy and Scott. If a gradualist policy is to be followed, it may be better to start with the existing framework and improve it. It is not at all likely that either of the proposals for comprehensive internationalization will be acceptable to the international community in the foreseeable future.

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[9] Christy and Scott, *supra* note 7, at 240.

[10] *Id.* at 241. We should point out that Christy and Scott do not advocate comprehensive internationalization, but call for study of all the available alternatives. *Id.* at 242.

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